FITNESS AND INJURY IN SPORT

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Care, Diagnosis and Treatment by Physical Means

by

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With a Foreword

by

SIR STANLEY ROUS, C B E,

Secretary to the Football Association

and Introductory Notes

by

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and

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To

All Sport, for its existence, and to all sportsmen everywhere, for their contribution, and to the memory of the late Mr A H Richards, a great sportsman and a great gentleman, this book is humbly dedicated

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PREFACE

I HAVE not intended this volume to be a text book. It is the result of many years of actual contact with athletes and athletic trainers, and the resultant compilation of facts, observations experiences and case histories during this period Rather may it be said that the book is intended as an aid in order that the methods which have proved satisfactory in so many cases may be of assistance to many others

My consultations and conversations with athletes and trainers during the past years have convinced me that some standard work *in simple language* would be of great benefit to them all and it was as a consequence of repeated pressure from them that I decided to embark upon such a volume. For the benefit of the majority I have endeavoured to *simplify the various technical terms* so that they be more easily understood, but it is not intended to produce half trained practitioners of physical medicine and I am certain that it will not do this My contacts with trainers of clubs large and small make me certain that they are responsible persons who will apply intelligently any treatment suggested and are willing at all times to increase their knowledge and boundaries for the benefit of their charges, their clubs and themselves.

If this book assists them in any way towards this goal then it will have succeeded in its purpose. It may also be the means of awakening the germ already in embryo towards that further and desired goal of proper competent, supervised training by which responsible athletic trainers may graduate from recognized schools and so do away for all time with the unqualified rubber who is a menace to all athletes

S S KNIGHT

Harrow-on the Hill
August, 1950

FOREWORD

By SIR STANLEY ROUS, C B E
Secretary to the Football Association

FOR a people to whom sport is a serious matter, the British, compared with many other nations, usually go about their games in a surprisingly un serious way For us the enjoyment and excitement are all that matter, and the meticulous attention to detail typical, for example, of the transatlantic specialist, is considered by most of us as tedious and irksome When we run after a ball, who cares what effect it has on the chemical structure of a certain muscle, or what it does to the para sympathetic nervous system? Such a light hearted view, of course, is basically to be admired, but I think most sportsmen after reading this book will come to the conclusion that as a nation we may have erred in the extent to which we have ignored the scientific approach

A fairly detailed knowledge of the different kinds of physiological development required by different types of games can be valuable for players and athletes, but for the trainer it is essential, and it is to him that this book is specially directed With its help, he will be able to gain a useful grasp of the development—muscular, respiratory circulatory and so on—he should aim at fostering in the men and women in his charge.

The author gives sensible advice on diet and expert instruction in the treatment of the commonest injuries The trainer may consider that some of the things Mr Knight has to say are counsel of perfection, but in any handbook there needs to be something of a blue-print in its make-up The author however, makes two simple, but none the less profound, points abundantly clear that good training is the best insurance against injury, and a happy man is more likely to become a good athlete than a sad one

Mr Knight concludes by making an interesting proposal for an Association of Certificated Athletic Trainers , to replace what he calls the present hotch potch of bucket and sponge

men I am sure he will concede that many of our trainers who have learned their craft empirically are second to none, but he is right when he says that the general standard should be raised considerably His book makes an important contribution to this end

INTRODUCTORY NOTES

By Denis Compton

I am very glad to be associated with the launching of a book, which, by its helpful advice, will do much for athlete, trainer and everyone associated with sport, to increase knowledge of the essentials, the groundwork, of sport, and to help make fitter, keener and better athletes, and better qualified trainers With the extra knowledge they can learn from this book, they may assist in the prevention of injury and, if the unfortunate should happen, then at least know how to get the sportsman well quickly and back into the game he loves and where the public want to see him. Not that this applies only to professional athletes for the same help, advice and treatment can be applied to all athletes, everywhere

This book sets a standard, it deals quite simply with a difficult subject or number of subjects, and I have no doubt of its success with the people it was written for

Denis Compton.

By BERNARD JOY

THE half back overreached as he went into the tackle and both he and the inside forward were off balance. There was a sickening crack which was heard all over the ground as their legs met and they fell to the ground The half back s thoughts flashed back a few years to when he had broken a leg while playing football and there had been the same resounding crack. Feeling no pain himself he thought, Poor chap I have broken his leg Then as he lay on the ground he saw the forward jump up and run away Good heavens, he muttered to himself ' it is my leg that is broken '

By this time the trainer was on the field. Come on, get up, he said. Not on your life—I ve broken my leg,' was the reply from the half back who knew only too well that a complicated fracture would follow the simple break if he put any weight on the limb The only response from the trainer was some massage to the hips and then he got his hands under the armpits to force him to his feet Only by physical resistance and an appeal to the ambulance men on the touchline was a greater tragedy averted

It sounds like a fairy story doesn t it? But it was not It actually happened in a senior match in which I played and the trainer was credited as being first-class at his job

The saying a little knowledge is a dangerous thing is never truer than with football injuries Soccer is blessed with a multitude of eager well-doers who can do infinite harm by misplaced enthusiasm. I know well because I gave myself the wrong sort of treatment for an injury during my early playing days and as a result I missed a whole season.

I believe Mr Knight s book will do much to improve our knowledge and treatment of injuries It will also help to take another step in the right direction by speeding up the cure of injuries A general practitioner will prescribe rest In a professional club and for a keen amateur player the need is to get back into action in the shortest possible time

I have left to the end the most important part of Mr Knight's work to which he rightly devotes the first chapters Injuries are definitely related to physical fitness—not only the general physical tone but also 'match' fitness The better equipped a man is for the game the less likely he is to receive an injury and the quicker his recovery if he does sustain one These chapters have therefore an appeal for the ordinary player as well as the trainer, coach or medical adviser

Bernard Joy

ACKNOWLEDGMENTS

No book of this type can possibly be written without the advice and help of many interested persons, authorities and clubs, and to all who have so unstintingly of their knowledge and time contributed I owe a debt of gratitude. I sincerely hope that they will have a measure of reward in finding the book in print. To Mr A H Richards I owe a special debt and it is a great personal sorrow to me that he is not alive to see the result of his advice for it was his primary encouragement and his insistence that such a book as this was necessary which made me undertake the task

To the many members of the medical profession, physicians, surgeons physicists, and so on, I must also pay tribute and my personal thanks are due to Dr I Eban, M.A., B.Sc., M.B , B Ch , D R.M.E for the loan of the excellent X ray photographs reproduced

I would like to thank my good friend Mr Edward D O Donnell chief Physical Therapist at the Department of Health, Yale University U S A for his kind assistance on many points and to Mr William Birrell, Secretary of the Chelsea F C. and to Mr Norman Smith, Trainer to the same Club for their co-operation. I owe a special debt to Mr Arthur Rowe, Manager of Tottenham Hotspur F C. and to his trainer Mr Cecil Poynton, for their help, and to the players of the Tottenham club who exercised so much patience while acting as models for the splendid photographs of the strapping and padding technique shown in Chapter XX. My thanks are also due to Messrs T J Smith and Nephew, Mr Harrison of the Medical Department, and to Mr Smith the photographic, artist, for co-operation and assistance on so large a scale.

I would also like to thank Dr Brian Stanford for his under standing and execution of the drawings and illustrations to the Central Council of Physical Recreation for their kind help and the loan of blocks in the chapter on general exercises, to The General Radiological Ltd , and to Messrs Barbers Electrical Services Ltd for their help and generous loan of

blocks and photographs, and to Dr Walter Summer, D.Sc., for his especial help on questions of physics.

I would also like to express my thanks for the loan of illustrations to Messrs Cox-Cavendish Ltd., to Mr Oscar State for the excellent photograph, and to *The Weight Lifter and Body Builder* for the blocks which have so ably demonstrated the ideas of weight training in Chapter xii.

Finally, though by no means least, I would like to pay a tribute to Miss Pat Churchill for her patience in deciphering my notes, and to Mr L. F. Norman for his help in checking the many technical points and the proofs.

S. S. Knight

CHAPTER I

THE BODY: DESIGN AND FUNCTION

THE body may be compared to a machine or a factory having a certain job or function to perform so that just as it is important for a good motorist to have a working knowledge of the combustion engine of his motor-car, so a good athlete and especially a good athletic trainer ought to have a knowledge of the function and structure of the body

It is intended that this work shall express simply and clearly and as consistent as possible with the medical terms a general understanding of all the subjects necessary for the maintenance of health and fitness of the athlete, and so that a trainer may be guided in his job by a useful grasp of the subjects involved without over elaborate technical terminology wherever necessary suitable explanations will be offered either in foot notes or in the glossary of terms

The study of the STRUCTURE of the body is known as ANATOMY This is a word derived from two others which literally means to cut up as indeed all our present knowledge of anatomy is founded upon the work of early pioneers who could only learn by dissection PHYSIOLOGY is the study of the FUNCTION of the body and again it is derived from two words which mean a knowledge of nature

Anatomy and physiology are, of course only two of the many branches of science Biology physics and chemistry are all interwoven in the study of the human body though a detailed knowledge of these is not necessary for the purposes of this volume

In every part of the body structure and function are closely related and this should never be forgotten All function is based on the anatomical structure which in the case of man is largely hereditary but does vary according to the needs placed upon it For example, the strength of a particular bone and the construction of the muscles attached to it, depends, to a great extent upon its use. Of course a structure which is weak because of injury may adapt itself remarkably to the demands placed upon it

The human body is composed of countless numbers of cells each being formed of a jelly like substance called Protoplasm surrounding a nucleus or centre A simple example of a cell is a single frog spawn It must be remembered however, that the cells forming the human body are so small that they cannot be seen without the aid of a microscope

Therefore we learn that every part of the human body is made up of countless millions of cells, bone cells, muscle cells cells which form the liver, the brain and so on Thus we can approach the body and divide it into its different systems These are

(1) Skeletal system.
(2) Muscular system
(3) Respiratory system.
(4) Circulatory system.
(5) Digestive system
(6) Nervous system.
(7) Reproductive system.
(8) Excretory system
(9) Glandular or Endocrine system.

To give the reader some insight into the functions and importance of these various systems we can briefly enlarge upon them

(1) *Skeletal System* The skeleton, comprising approximately 214 bones in the adult and forming about one-seventh of the weight of the body It acts as the framework of the body and forms the attachments for the muscular system

(2) *Muscular System.* Is made up of about 434 muscles, attached to bones to hold the skeleton together and to move the skeleton from place to place

(3) *Respiratory System.* Enables the body to breathe in fresh air thus oxygenating or purifying the blood and to pass off carbon dioxide, a waste product of our energy

(4) *Circulatory System* This enables food and oxygen to be carried to all parts of the body and assists in the elimination of waste products

(Note It is greatly assisted in its work by the LYMPHATIC system, which is an auxiliary to the circulatory system.)

(5) *Digestive System.* Allows the passage of foods to the stomach and intestines where the food is acted upon by many substances

and converted into other substances which are easily absorbed into the blood stream The unwanted parts are excreted

(6) *Nervous System* May be likened to a telephone exchange —the brain, the main cables—the spinal cord, the separate lines or wires—the nerves The nervous system is responsible for co-ordinating every occurrence in the body and acting upon the information received

(7) *Reproductive System* In the male and the female are responsible for the reproduction of the human species

(8) *Excretory System* Is divided into four sections (*a*) skin, (*b*) kidneys, (*c*) rectum, (*d*) lungs each giving off waste products unnecessary to the body

(9) *Glandular or Endocrine System* The glands have the important function of making secretions of substances which are poured into the blood stream in order that certain conditions occur in the body to maintain the proper balance of life and health. Too much or too little of these secretions throws the body off balance. For example the pancreas secretes Insulin and a shortage of this substance causes Diabetes

The lower forms of animals take in substances through their surfaces but in the higher animal, of which man is the highest, there are special inlets which are adapted for this purpose Here are one or two examples LUNGS are adapted to take in OXYGEN and to give up CARBON DIOXIDE, and the DIGESTIVE TRACT takes in nourishment in the form of food which is eaten and digested From these organs these substances are transported by the BLOOD to the regions where they are needed and the waste products are then transported to the regions from which they will be excreted

Most of the nourishment supplied is used by the voluntary muscles when they become active. They form about forty per cent of the total weight of the body, and man not only uses them for his activities but for any sustained exercise which he undertakes

The voluntary muscles are under the control of the will and the brain sends messages to them by means of the nervous system It would appear from study that much of the work of the body functions principally to supply the needs of the voluntary muscles

It is interesting to compare the function of the muscles with the engine of a motor-car In both cases chemical energy is converted into mechanical energy Chemical energy is

supplied as Carbon (C) and Hydrogen (H) which unite with Oxygen in the muscle to form Carbon Dioxide (CO_2) and Water (H_2O) The vessel which carries the supply of energy in this uncombusted state is the ARTERY and the products of combustion are carried away by the VEINS. The essential elements of petrol for the engine of the motor-car are also Carbon and Hydrogen and the exhaust from the petrol accumu lated is Carbon Dioxide and Water The motor-car is supplied with petrol while oxygen is drawn in at the carburettor In the body the fuel we need is supplied by the food we eat and the oxygen we breathe The digestive tract and the lungs are inlets from the body surface with which they are continuous at the mouth and the nose Other things besides food and air *may get into the digestive and respiratory tracts of which* bacteria may be one If they get into the blood stream or the muscles serious harm would be caused It is in the study of the structure of these tracts that we can see how they constitute areas upon which the food and air are spread out in contact with blood and separated from it by a thin layer of cells From these surfaces absorption into the blood stream takes place by a series of processes

Fuel for the body is for the most part supplied by starchy foods and fats, but there are a number of other substances which assist in the building up and repairing of the body tissues Like running repairs of a motor-car they are needed in less quantity if the condition and general state of the body is good All human tissue consists of substances which have been part at some time or other of living tissue either of plants or animals This is especially true of Protein a substance containing nitrogen of which all living tissues are built In addition to protein the body takes in small quantities of iron for the blood, calcium for the bones iodine for the thyroid gland and vitamins for a number of purposes All these substances are obtained from foods derived from animals or plants though some elements such as iron and calcium may be taken in an inorganic, or non living form

What is said for muscle can apply to all tissues of the body with the exception of the heart where less fuel is used In order to keep these alive and to repair themselves all tissue has to use a certain amount of fuel and it is supplied in the same way as to muscle. This repair of the tissues is constant and the slowing down is a characteristic of old age The heart and lungs

are essential organs of life, but they are for the most part servants of the muscles and most of the work they do depends on the needs of the muscles For example, if we take heavy exercise, more work is done by the heart and lungs As this exercise makes us hungry, more work is done by the digestive tract When we rest these organs are also at rest, and therefore less work is done by the body generally That is why we are told to rest in bed sometimes when we want muscles or organs to repair themselves as quickly as possible with the minimum of effort

CHAPTER II

MUSCULAR ACTIVITY

WHEN a muscle contracts it does not change its volume The same amount of muscle is there but it has re-distributed itself The muscle first of all shortens grows thicker and when you touch it feels hard and firm The muscle is made to contract by the passage of a *nerve stimulus from the brain to its centre of* activity which is called the motor point of the muscle It is also possible to contract a muscle by tapping it sharply with a rod or even a fountain pen As a part of his work the physiotherapist very often has to stimulate a muscle or a group of muscles He can do this by the application of an electric current or by using chemicals If a muscle, because of an injury, cannot *move by itself it must be made to move by these other means* These artificial contractions and stimulations are very necessary in many cases of injury so that the muscle is prevented from wasting

A muscle is normally made to contract by a nerve impulse which comes to it as we have seen from the central nervous system. In the case of voluntary movement which is under the *control of the will thus comes from* the brain Let us see exactly how this occurs

When a nerve impulse passes down a nerve a chemical change takes place and a minute amount of electricity is produced When the nerve impulses reach the muscle it causes the release in the region of the nerve ending of a chemical substance which we call ACETYLCHOLINE, which acts on the muscle and is then destroyed Thus we see that the contraction of the muscle by a natural impulse or stimulus is very short so that if a number of contractions or a sustained contraction is needed then a number of *impulses or a sustained impulse must* pass from the brain to the muscles

It would be interesting to watch a muscle contraction on yourself Flex the biceps muscle in the upper arm and examine it while it contracts You will note a change both in distribution of muscle fibres and outline. The form is rounder yet it is harder to the touch At the same time a very elaborate number of

chemical changes take place and though it is not necessary to go into detail a brief summary may be indicated as follows the food carbohydrate[1] is changed into Blood Glucose[2], which then changes into Glycogen[3] There is then a conversion of the Glycogen into Lactic Acid[4] and finally what is left is Carbon Dioxide[5] and Water Of course this description is only very cursory but it will give the reader a general picture.

For the original contraction oxygen is not necessary, because muscle will contract quite well in an atmosphere of nitrogen but, and this is important, it will not recover for the next contraction if no oxygen is present If this occurs it shows that there is an accumulation of lactic acid in the muscle and its continuance will cause a very rapid onset of fatigue. This is true of the body generally as for example you may prove for yourself if you run after a bus or train While we are running for a short period we do not need to breathe, but afterwards we are very breathless This breathlessness is due to the rapid intake of oxygen necessary for our recovery The body is said to have an air hunger and we gasp and gasp until we have got enough air into our lungs This seems to prove the theory that muscle is capable of incurring an oxygen debt and it must be remembered in all training for athletics

The substances which form in muscle when it contracts have a considerable importance in a practical way for they act on the walls of the capillaries in the muscle. This causes a dilation or enlarging of the capillaries and by this means a larger supply of blood is transported to the active muscle. What is also of importance is that because of the smallness of the molecules in the muscle tissue combining with the substances from which they are formed water is attracted into the muscle fibres and causes a swelling if there is too much. It is thought by many authorities that this swelling is responsible for the stiffness which occurs after heavy exercise In a well-trained athlete this swelling does not take very long to leave the muscle because there is an efficient local circulation of blood and lymph In the case of persons unaccustomed to exercise

[1]Carbohydrate Food which creates energy—heat—and stores fuel.
[2]Blood Glucose End product following the digestion of starch foods, carbohydrates and the sugar of fruits
[3]Glycogen Is converted glucose stored in the tissues until required by the body when it is reconverted into glucose in the liver and passed back into the circulation
[4]Lactic Acid End product of glycogen created by muscular activity
[5]Carbon dioxide Waste products resulting from muscular activity



The drawing shows an analysis of muscle power required in sprinting. Note the development of the thigh muscles vital to the sprinter. Exercises for thighs and calf muscles are specially necessary.

Demonstrated by
MacDonald Bailey

where the local supply of blood and lymph is not so good the swelling may last for many days

Soon after we commence exercise our body becomes warm This is because the muscles produce heat when they contract There are two main reasons for this, firstly, the interior of the muscle is viscid, that is it is glutinous or sticky, and there is friction between the various components of the muscles, and secondly heat is released when oxidation, or the chemical change which allows oxygen to be given up takes place during the period of recovery The release of this heat causes an increase of temperature which has two important functions namely the drawing off of oxygen from the blood, and the dilating or enlarging of the local blood vessels

It has already been noted that when a muscle contracts an electric current is produced in the muscle It is the study of such currents which have proved that voluntary movement is the result of a fusion of a vast number of contractions

When a muscle contracts it does something in addition to bringing about the movement of the body The contraction compresses the blood capillaries and squeezes the blood from them into the veins. This is of great assistance in exercising a muscle because it increases the local circulation.

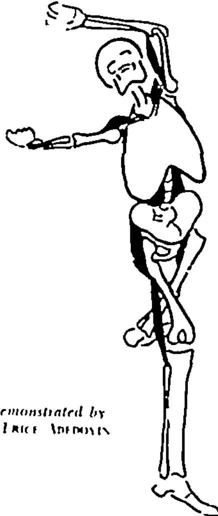
We all know that excessive use of any particular muscle or set of muscles will lead eventually to fatigue. It might be thought that this is solely due to exhaustion of the muscle but actually this is not so For instance if a muscle cannot be stimulated through its nerve it is possible to contract it directly through the muscle itself. This can be done by applying electrodes from a faradic or galvanic battery direct on to a muscle If then a nerve block, such as a piece of ice, is placed on the nerve and then we stimulate the nerve for any length of time the muscle will at once contract when the ice block is removed This shows that the nerve between the stimulus and the block is not fatigued This seems to indicate that the fatigue occurs in the region of the nerve ending and probably because the muscle is exhausted and its mechanism cannot produce the substance of acetylcholine Before a contraction can take place we have seen that it is necessary to have a nerve stimulus or impulse. It is believed by physiologists that the chemical substance which we know as acetylcholine is liberated at the nerve endings by the arrival of the nerve impulse The act of contraction occurs and the acetylcholine is destroyed

Fatigue in voluntary muscle is expected as a natural corollary of heavy exercise. But the picture is further complicated as it can be shown that even when the muscle is fatigued it is still possible to contract it by stimulating its nerve through the skin This tends to prove that the fatigue may not always be in the muscle but is actually in the nervous system. It is possible that the fatigued condition arising in the muscle sends impulses back to the nerve which prevents the muscle being used to excess and so avoids harmful or complete exhaustion

In addition to local fatigue in muscles there is also a general fatigue which appears to be due to a general exhaustion and may be caused by the accumulation of fatigue products in the body Such fatigue may be prevented by cutting down all unnecessary *movements and the movements of large bulk of* muscles It is surprising how such a small thing as a blister on the foot can cause fatigue because it calls into use larger groups of muscles which are not normally used in running or walking

The sensation of fatigue occurs when muscles are used to excess It seems probable that a concentration of fatigue products assemble in the fatigued muscles and that they stimulate the sensory nerve endings in the muscle thus causing pain It is almost certain that one of the most important offenders is lactic acid for this substance seems to accumulate in a fatigued muscle especially when the local circulation is deficient. There is indeed evidence that a solution of lactic acid will produce fatigue and certainly general fatigue depends upon the amount of muscle used.

It is therefore essential, if we wish to get the maximum benefit from our muscles to see that they are not over fatigued and that the local circulation is enough to get rid of the acid as and when it is made Certainly activity benefits in many cases by rest, but these rest pauses should be regulated and properly spaced Too much rest following hard exercise will lead to laziness and waste in the muscle and if this is continuous a reduction of output of the muscle strength will follow On the other hand too much work is equally bad. Usually the common sense of the athlete or the trainer will be the best judge of the amount of rest necessary Every athlete must assess for himself the individual capability of his muscles and every period of hard work should be followed by a sufficient period of rest but not too much so that activity is impaired It is the trainer's job



High jumping requires particular development in all leg muscles. In addition pay attention to the muscles of the abdomen and the shoulders

Demonstrated by

therefore to make careful calculations of the 'quality' of the muscle in any athlete and together with a common sense assessment of the tone of the body as a whole he will know how to space the work and rest periods

CHAPTER III

MUSCLES AT WORK

When they are working muscles have three essential properties They are (*a*) Contractility, (*b*) Extensibility, and (*c*) Elasticity

To a great extent these properties exist in muscles when they are at rest but, of course, only to a smaller degree

When muscles are not actually engaged in the performance of a movement they are in a slight state of contraction This is known as muscle tone about which more will be said later All healthy voluntary muscles show this state of tone to some extent, but it is greater in those muscles which assist the erect posture against the force of gravity Muscle tone may be simply described as a state of the preparedness' of muscle tissue to respond to a call to action, and conversely poor tone in muscles will inevitably produce a poor response

A muscle can be compared to a piece of elastic If you stretch elastic it gets longer and thinner and when it is released it will recoil With elastic, however, the extension is uniformly extensible each portion of it stretching under the same weight, pull or tension Muscle will stretch only a definite length, and with increasing tension or pull it will stretch less and less beyond a certain length. Once it has reached the limit of its easy extension there is some resistance

One of the odd things about extensibility in muscle is that it is actually increased by contracting That is to say a given weight stretches a contracted muscle more than it does the same muscle when it is not contracted This is important because it reduces the liability of a muscle to be torn from its attachment if contracted suddenly or if the muscle is cold

A muscle has a further safeguard by what is called the lengthening reaction which depends upon the nervous system This means that whenever the tension or pull is too great, further contraction becomes impossible and it will in fact relax

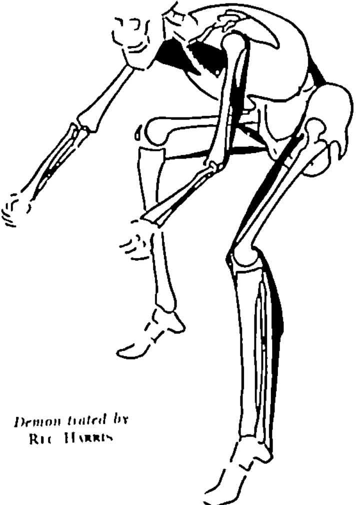
Extensibility in a muscle must not be confused with relaxation of tone As already stated all muscles while at rest are in a state of partial contraction This is known as tonus During

the contraction the opposing muscle, called the 'antagonist, is reduced through the automatic action of the nervous system, and thus produces an appropriate relaxation After a muscle is moved it can be brought back to its former position by the movement of the antagonist, and also by a relaxation of the first muscle. Thus we see that muscles are arranged in pairs, each pair being antagonistic to the other

Muscles are generally named according to function Those which bend the limb are known as FLEXORS those which straighten are EXTENSORS. If you place your right forearm on a table and twist your wrist to the left or right you will notice that the palm of the hand is facing upwards when the wrist is turned to the right. This action is known as SUPINATION, and *if you now reverse the process, turn your wrist to the left and* cause the palm to face downwards it is PRONATED If you lie flat on your back with your face to the ceiling your body is said to be in SUPINE position and if you are on your stomach with your face to the floor you are in the PRONE position. The ADDUCTORS are those muscles which draw your limbs towards your body and the ABDUCTORS draw the limbs away from the body ROTATORS assist in rotation movements

The erect position of the body is maintained by the combined influence of a number of muscles acting at the same time. The whole weight of the body rests on the arches of the feet. The body may be supported in any position providing its centre of gravity is situated vertically over any point in the space enclosed by the feet On account of the large number and suppleness of the joints the centre of gravity cannot be maintained without the contraction of certain muscles which give rigidity to the body

When a person begins to walk he first inclines the body forward then raises one foot swinging the leg forward one step and the foot to the ground again Now for a moment the legs form with the ground an isosceles triangle, but, before the foot reaches the ground the contraction of the calf muscles of the other leg raises the heel and propels the body forward The weight of the body is thrown on the first foot, and the one behind swings forward and passes in front of the other A forward motion is thus given to the body which can be maintained for a considerable time without the expenditure of much energy It will be noticed that in walking both feet are never off the ground at the same time.



Demonstrated by
Ric Harris

The racing cyclist needs a developed and muscular body. He must develop power in thighs, calves, back muscles, and also in shoulder and arms. Pay attention too to the muscles of the chest wall (pectorals) for development here adds endurance.

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The erect position of the body is maintained by the combined influence of a number of muscles acting at the same time. The whole weight of the body rests on the arches of the feet The body may be supported in any position, providing its centre of gravity is situated vertically over any point in the space enclosed by the feet On account of the large number and suppleness of the joints the centre of gravity cannot be maintained without the contraction of certain muscles which give rigidity to the body

When a person begins to walk he first inclines the body forward then raises one foot swinging the leg forward one step and the foot to the ground again Now for a moment the legs form with the ground an isosceles triangle but, before the foot reaches the ground the contraction of the calf muscles of the other leg raises the heel and propels the body forward The weight of the body is thrown on the first foot and the one behind swings forward and passes in front of the other A forward motion is thus given to the body which can be maintained for a considerable time without the expenditure of much energy It will be noticed that in walking both feet are never off the ground at the same time

As the forward motion of the leg is a swinging motion it follows the law of the pendulum The longer the pendulum the slower it swings Hence the natural step of a child is much quicker than that of a grown man Running differs from walking in that the heels are not brought to the ground, and both feet are off the ground for short periods at each stride. Contraction of muscles is much more rapid and powerful, and the contraction of the extensors of the thigh adds greatly to the force which propels the body forward Thus any athlete who can increase the power of contraction of the thigh extensors can increase his speed and particular attention to preserving tone in these muscles is an advantage

Jumping resembles running as far as the action of the muscles is concerned, but the legs act simultaneously instead of alternately so that the body is thrown forward to a greater distance

In all athletic pursuits not only muscles but also the LEVERS of the body play an important part Strictly speaking a LEVER is a fixed bar capable of moving freely on a fixed point. This fixed point is known as the FULCRUM, and it is the point through which the weight of a given action will pass Levers are of three orders depending on the position of the fulcrum, the place at which the force is applied and the point where this force is resisted

First order This is where the fulcrum is between the power and the weight as in a see-saw

Second order in which the weight is between the fulcrum and the power

Third order is where the power is between the fulcrum and weight.

The majority of the levers found in the skeleton are of the third order

Muscle Tone

I have stated earlier that muscle tone is a state of preparedness of muscle for action The importance of muscle tone cannot be too greatly emphasized for it is this tone in the bulk of the body muscle itself which will make the difference between a split second action and a sluggish action The trained athlete must have split second action and therefore he must have tone. The muscle has to be ready to move when it is instructed, or in other words when the impulse is first received It is useless

Analysis in hurdling shows requirements of power in thigh and hamstrings shoulders and abdomen Good muscle tone will make for agility

Demonstrated by
Don Finlay

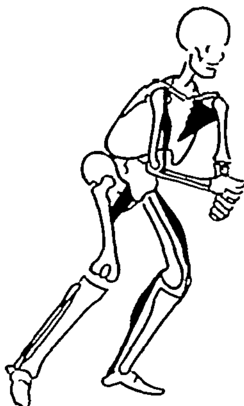




Muscle analysis in both cricket and golf shows predominant power requirement in shoulders arm and wrist. For quickness of movement, good tone in leg and foot muscles is necessary

Demonstrated by
Bobby Locke
and
Denis Compton





developing mere bulk in a muscle when tone is absent, for the simple reason that an over bulky muscle cannot respond to the call made upon it when it is most necessary

If you place your hand over a muscle it should feel slightly firm, elastic and give a little to the touch. It is not fully relaxed even when it is not being voluntarily contracted This is a good test of the state of tone in a muscle The reason for the quickness in response in muscle in tone is simply that it has no slack to be taken up

Types of Muscle Work

Muscles are said to have a point of ORIGIN and a point of INSERTION To perform the function of contraction a muscle needs a normally fixed point of attachment—its origin, and a movable point of attachment—its insertion A muscle rarely has a completely fixed point of origin. This does occur in some places, for example, in the face, where one end of the muscle arises from an immovable bone and inserts into the skin providing the muscles of facial expression.

Muscles are described as working in the following ways (*a*) CONCENTRICALLY (*b*) ECCENTRICALLY and (*c*) STATICALLY

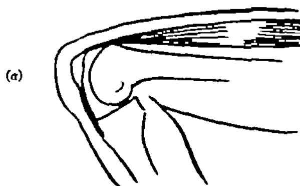
(*a*) *Concentric Work* During this type of work the muscle becomes shorter and thicker and feels hard because the origin and insertion approach each other Usually the insertion approaches the origin because the latter is the more fixed

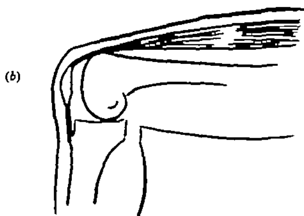
(*b*) *Eccentric Work* This occurs when a muscle is in action but the attachments are drawing farther apart and the muscle gets longer and thinner It still feels hard because it is working In other words, it is lengthening itself by gradually letting go to the pull of an outside force

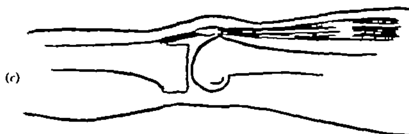
(*c*) *Static Work.* This happens when a muscle or group of muscles is at work to hold a given position No actual movement takes place although the muscle is definitely in action. For instance when a policeman on point duty extends his arm horizontally the abductor muscles of the shoulder are working statically because the pull of gravity tends to force the arm to the side Static work is undoubtedly the most tiring work of all Most soldiers will tell you that it is more tiring to stand to attention on a parade for some time than engage in any active exercise The reason is this—fatigue products collect in the muscle and because of the slowness of the circulation in a not so active muscle it is harder to get rid of them.

Range of Muscle Work

Muscles may work in three different ranges. FULL RANGE—this is the path traversed by a muscle when it contracts from its greatest possible lengthening to its greatest possible shortening. This distance is usually divided into Inner and Outer range. INNER RANGE—is the distance between the midpoint of its full range and its greatest possible shortening. OUTER RANGE—is the distance between the greatest possible lengthening and the midpoint of full range.


(a)


(b)


(c)

Full range is shown by the greatest possible lengthening to the greatest possible shortening and is demonstrated by (*c*) to (*a*).

Inner Range is the distance between mid point of full range and the greatest possible shortening (Figs (*b*) to (*a*))

Outer range is the distance between the greatest possible lengthening and the mid point of full range and shown by Figs (*c*) to (*b*)

The beginning of a sprint race demands a high degree of development in the general musculature. Power is specially necessary in thigh, calf and back muscles while a well developed shoulder muscle will give a lift to the body at the take-off

Demonstrated by
MAUREEN DYSON

CHAPTER IV

GROUP ACTION OF MUSCLES

MUSCLES constitute the red meat of the body and have already been described as having a point of origin and a point of insertion. The ORIGIN under normal movement remains fixed and the INSERTION is the part which moves. Therefore muscular movement generally takes place from the origin of a muscle *towards* its insertion.

In order to more fully appreciate the action of muscles perhaps a brief description of structure and attachments will be helpful. Generally speaking muscles have their main attachment to bone, but sometimes they are attached to the deep fascia or the skin. This has been mentioned earlier you will remember in the muscles of facial expression. Some muscles are attached to the tendons of other muscles Most muscles especially those from the long bones are directed straight from the point of origin to the point of insertion, but in the case of other muscle groups where for the sake of economy of movement a smaller contraction and a more rapid muscular action is necessary they are directed obliquely Some muscles in the trunk are a good example, to enable us to turn our trunks with the simplest possible movement and incidentally the great saving of a considerable amount of energy

Each muscle consists of a large number of muscle fibres bound together in bundles and very largely the shape of the muscle will depend upon its arrangement of fibres. These fibres are the working parties of the muscles but they are not all working at the same time.

A muscle may be fully contracted but this does not mean that *all* the fibres are in action. A considerable number are held in reserve, and when their fellows get fatigued they are ready to take the strain. It is a matter of doubt whether a muscle is completely at rest because some of the fibres are in action under all circumstances and it is this which is responsible for producing the tone in muscle to which reference has been made.

Muscles act on joints and perform certain movements which can be grouped as follows

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Muscles act on joints and perform certain movements which can be grouped as follows

Again a good general musculature is necessary Tennis requires physical development and mental alertness A good eye perfect muscle tone and posture are vital

Demonstrated by
Fred Perry

(*a*) *Protagonists* These are the prime movers in any muscular action

(*b*) *Antagonists* These are considered to exercise a controlling influence on the action of the protagonists Their function may be described as 'paying out the slack as perhaps one might control a moving object by relaxation of a rope attached to it. Antagonists also control movements initiated by gravity For example, hold your arm horizontally extended, you will notice how difficult it is to keep it in the same position without some effort owing to the pull of the gravity force. The antagonistic effort of the adductor muscles of the shoulder enables your arm then to remain in the extended position as long as you wish.

During infancy we are much occupied in teaching the antagonists to control the protagonists, for until co-ordination between these groups is perfected we are unable to hold the body erect to stand up or even to walk You will gather then that this controlled relaxation which we take so much for granted is the result of much practice and training

THE OBJECT OF ALL PHYSICAL TRAINING MUST BE TO PRODUCE A CO-ORDINATED AND CONTROLLED MUSCULAR RELAXATION WHICH IS THE KEY TO BALANCE, POISE AND GOOD POSTURE, SO ESSENTIAL IN THE ATHLETE.

(*c*) *Synergists* are the third group and they collaborate with the protagonists Their function is to facilitate and localize a particular movement For instance, take the case of a boxer getting ready for a fight Before he can hit his opponent with any effect he must make a fist, but if he just flexes his fingers and wrist he only makes a feeble fist. There is very little hitting power So if a good fist is to be made, with strong hitting power it is essential to flex the fingers *and* extend the wrist The wrist should be extended to the midpoint of its range and the fingers flexed compactly the wrist should be then turned horizontally so that the power of each punch is delivered with the knuckle part of the fist. The clenched fingers are facing downwards and *not* up and down. If the latter is done, the muscles of the fore arm and the biceps are often jarred and perhaps a bone in the wrist may be broken I have seen this happen often, especially by amateur boxers although professionals are not altogether faultless on this score. Now assume that you have in fact made your good fist. It feels light but strong and is a good weapon How has it then been achieved? The extensors of the wrist have acted as collaborators or SYNERGISTS in the movement, and

CHAPTER X

EXERCISE AND CIRCULATION

THE circulatory system consists briefly of the Heart, the Arteries the Veins and the Capillaries The Heart is the main organ of circulation and is responsible for pumping the blood through the body The Arteries convey the blood from the Heart and it is then carried through the Capillaries, into the Veins, and back to the Heart The colour of the Arterial blood is bright because it has been oxygenated or purified, and the blood in the Veins is dark and dusty because it carries the waste Capillaries are small vessels connecting the two, and there are many blood capillaries which form an auxiliary system, the ABSORPTIVE, and their duty is to collect nutrition from various parts of the body and empty it into the blood stream It also helps to repair waste and furthers growth.

The effect of exercise on blood circulation is enormous, the rate of circulation being increased at least three times in an ordinary person unaccustomed to exercise and, of course, much more than this in a trained athlete The increased flow in the active muscles is produced in two ways—by dilating (enlarging) the blood vessels in the muscles themselves, and by a rise in blood pressure

Blood consists of a fluid or PLASMA which is ninety per cent water and the remainder is protein or albuminous very much like the white of an egg There are also some salts, especially sodium chloride (common salt) The amount of salt present in the blood is normally 0 9 per cent and this is referred to as NORMAL SALINE which is often used as a blood substitute after severe bleeding It is easily made by adding a teaspoonful of salt to a pint of water Blood plasma therefore is faintly alkaline and it never becomes acid since an acid blood is not compatible with life In the body there are a large number of chemical mechanisms which see to it that the alkaline reaction is constant

In the fluid or plasma are suspended the RED AND WHITE CORPUSCLES and naturally the former are so-called because they contain a red iron pigment which is chiefly responsible for the carriage of oxygen and carbon dioxide. When blood is fresh,

by first extending and then fixing the wrist, they enable the flexors of the fingers to act powerfully They have also helped to release a 'tautness' in the forearm muscles and the biceps of the upper arm

(*d*) *Fixation Muscles* collaborate with the protagonists by steadying or fixing the bone or bones from which the protagonist originates or into which it is inserted For example, the biceps could not take any part in flexing (bending) the elbow joint when the forearm is pronated (that is the palm is face downwards) since the muscle is naturally a supinator (it normally assists in the reverse movement and turns up the palm when the elbow is flexed or bent) if it were not for the fact that the radius (bone of the forearm on the thumb side) has already been fixed by the pronator muscles

It will have been seen that muscles never work singly They are always in group action, and it is this harmonious interplay within the group which brings about the perfectly controlled and co-ordinated active movement, no matter how simple or difficult it may be.

You will have read earlier that all muscles work from the central nervous system by what are known as 'motor nerves There are also sensory' nerves by which impulses pass back to the brain So you can see that nerves not only cause muscles to contract but they are essential in the preservation of good tone in the muscle At the same time they convey messages from the muscles to the brain which is essential for co-ordination and sense of position.

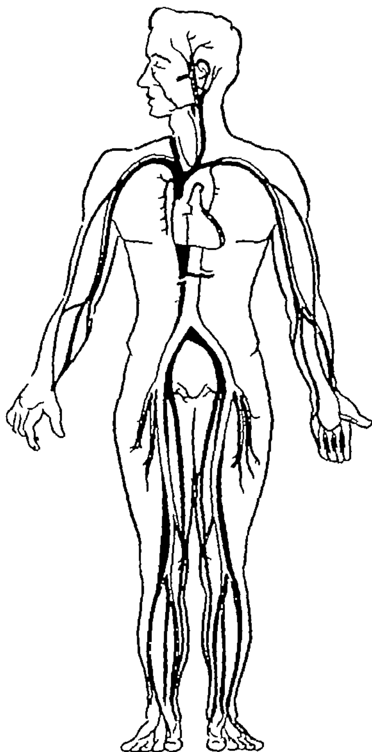
All muscles have a good blood supply but tendons do not Most tendons have a covering or sheath to avoid friction, and these sheaths secrete a fluid which acts as a lubricant and helps its movement. When a tendon is strained these sheaths become inflamed and often give rise to a condition common to most athletes at some time and known as tenosynovitis The name arises from the name of the sheath of the tendon—SYNOVIAL SHEATH—and the fluid it contains is SYNOVIAL FLUID

the pigment is soluble and can easily be washed If you cut yourself and wipe up the blood with a handkerchief it is easy to wash the blood out by rinsing under a cold tap Once the blood has dried, however, the pigment changes character and is difficult to remove Red blood cells are made in the red bone marrow which occurs in the ends of the long bones and in the flat bones of the body Perhaps this gave rise to the old saying "What's bred in the bone comes out in the flesh" In the unborn child the red cells are made in the long bones, the spleen and the liver Red blood corpuscles live only a very short while and are constantly renewed It might be interesting to note that of all the cells in the body mature red blood corpuscles are the only ones which do not possess a nucleus

White blood corpuscles are fewer in number than the red cells. They can be called the fighters of the body and scavengers of the blood for they take up and digest bacteria. If you examine pus from an infected wound, you will notice its characteristic colour is due to the white corpuscles which have been killed by bacterial toxins while defending the blood's healthy state. As soon as an infection occurs these white cells leave their storehouses and their numbers in the blood are increased This also happens during exercise and is a protection against the waste products

The average person has about nine pints of blood of which one pint may be removed with safety Its use is that it acts as a transport system carrying substances all over the body wherever they may be needed Its circulation is so controlled that it can increase the amount of blood to any part of the body which is active. The whole mechanism is keyed to mostly meet the needs of the voluntary muscles, it can compensate itself for any loss of blood and adapts itself to changes in the posture of the body Changes during activity are brought about by raising the blood pressure and by opening up blood vessels in the active part at the same time

When a muscle is brought into action and contraction occurs a number of chemical substances are produced which enlarge the circulation in the capillaries The most important substances are lactic acid and carbon dioxide An idea of this enlarging (or dilation) can be easily demonstrated if we tie a piece of string round a finger for a few minutes When the circulation through the finger is stopped the chemical substances produced by the tissues accumulate. When we remove the



This illustrates the direction of flow of blood in the main vessels the light lines denoting arterial flow and the heavy shading the venous return

The best long-distance runners are those with slow hearts, where the heart rate is normally around fifty and the heart has in these instances a greater range. A normal untrained person having a heart rate of say, eighty, would never make a distance runner In fact he would never make a runner over any distance

It is my own opinion that all athletes in training should have a weekly check on the heart rate by the club doctor A heart rate of over seventy is certainly too fast for any athlete in training

string we see that the finger will flush because of the greater amount of blood present in the dilated or enlarged capillaries of the skin When a muscle contracts it produces heat, and this heat brings about a relaxation of muscles, including the muscular walls of the blood vessels To some extent the nervous system has a controlling effect on blood vessels

The Control of the Heart

The Heart is a pump but it is different from any artificial pump in that it can increase its output according to the needs of the body It does this in two ways—by increasing its *output per beat* and by increasing its *rate* The heart does not suck blood, it is filled by blood under the pressure in the veins—the higher the pressure the more the heart is filled. It can enlarge to the limit allowed by the wall of the heart (pericardium) [1] When extra blood reaches the heart its muscular wall is stretched To counteract this, the heart contracts with some force and drives out the extra blood The rate of the heart is governed by an area near the entrance of the great veins and is known as a pace maker' This area is affected by impulses which come from the nervous system and are distributed throughout the heart. When the pace maker is stimulated, the impulse spreads out in a fan shape to a bundle of tissues which conduct the impulse through muscles to parts of the heart cavities

The heart has an action which quickens or accelerates it, and another which retards or diminishes it They are both controlled by sets of nerves, and these are called SYMPATHETIC for the former and PARA-SYMPATHETIC for the latter It is the action of the para sympathetic which slows down the rate of the heart when we are at rest, and if it were not for this we would get very little benefit from rest These nerves must not be taken as being in any way in opposition as in the case of muscles Actually they can be classed as co-operators for when the activity of one is increased the activity of the other is decreased It can be easily understood from this that the more exercise you take, the more active does the para sympathetic become, and as a result of this the heart has a greater range of activity In all cases of physical activity or in the mental excitement which often precedes or follows physical activity the activity of the sympathetic nerves is accelerated while the activity of the para sympathetic is diminished

[1] Peri—around cardio—the heart.

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CHAPTER VI

EXERCISE AND RESPIRATION

THE main organs of Respiration are the Larynx (or voice box) the Trachea, a tube which extends from the larynx to the chest and two smaller tubes dividing from the trachea known as the Bronchi and the Lungs

Many of the lower animals can take in the oxygen they require through the surfaces of their bodies but man, being a higher animal, depends on the LUNGS All living things require oxygen or they die Oxygen is used as we have already noted, to burn the Carbon (C) of the foodstuffs and to convert it into carbon dioxide (CO_2) and hydrogen, which is converted into water (H_2O)

Lungs can be simply described as a large mass of spongy substance consisting of smaller sponges or Sacs all stuck together

The tube, or Trachea is kept supported by a series of cartilaginous rings and you can easily feel them if you press on the neck It divides into two main tubes, the Bronchi, in the upper part of the chest, and then sub-divides into smaller and smaller tubes called Bronchioles The bronchioles open into the air sacs of the lungs which are known as the ALVEOLI.

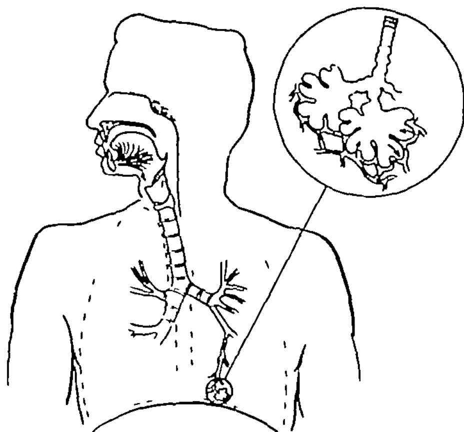
In the bronchioles the cartilage rings are replaced by rings made of the muscle fibres which at each expiration (breathing out) contract In the normal person this contraction is only slight, but in persons suffering from certain respiratory diseases such as asthma, the contraction will be excessive.

Dividing the chest cavity from the abdomen is a thin muscular partition called the Diaphragm, which is used in respiration It is normally dome shaped but when you take a deep breath the dome flattens and at the same time the ribs are raised so that the capacity of the chest cavity is increased and there is room for the air which you have taken in As there is no other opening into the chest but the trachea and the blood vessels, air (and blood) are sucked into it during each inspiration (breathing in)

The structure of the lungs is adapted to its function In the

alveoli the air comes into contact with the blood and in some places the same cells act as a wall to both an air alveolus and a blood capillary

During exercise more oxygen is used by the body, so that blood in the veins contains less oxygen and more carbon dioxide In heavy muscular exercise blood in the arteries also contains a large amount of carbon dioxide



This shows the Trachea the Bronchi and the Bronchioles and the Lungs and Diaphragm in outline and the smaller inset has been enlarged to show the principles of respiratory exchange of air and blood in a lung alveolus

Respiration is controlled by the chemical composition of the blood and by nervous impulses There are in the brain certain areas known as the respiratory centres which are sensitive to changes in the amount of carbon dioxide in the blood. A definite amount of carbon dioxide is necessary in the arterial blood for the proper function of the respiratory centres This can be

demonstrated on yourself If you purposely overbreathe, the air in the lungs becomes almost like atmospheric air An excess of carbon dioxide leaves the blood and passes through the lungs Therefore the brain gets less and normal respiration is reduced So you can see that it is the carbon dioxide in arterial blood which goes to the brain and is responsible for stimulating those parts of the brain, which control the centres of respiration and circulation.

Many of you will have heard that a new born baby receives a hearty smack on the buttocks This is done for a very definite reason. Respiratory centres are stimulated by the nerves, especially from the skin. As the respiration of the baby was not efficient, an energetic stimulation of the skin nerves was performed by the smack on the buttocks. This causes the child to gasp and generally it breaks into a loud cry, which brings into function the normal respiration

We will have seen so far that adequate respiration depends on, principally a good circulation, sound lungs and proper function of the blood to carry oxygen and other gases

Breathlessness occurs often in exercise and this is because there is too much carbon dioxide in the blood At first, the additional carbon dioxide produced by the burning of carbon goes through the lungs into the arterial blood This stimulates the centres of respiration which sends down messages and the chest breathes more deeply until the respiratory movements are adjusted to the needs of the body

Often breathlessness occurs at times of quiet and rest and this should be taken care of by consulting the club doctor

There is no doubt that exercise is the best way to increase respiratory activity and the capacity of the chest and lungs

Breathing exercises are generally sound and efficient, but they must be done carefully and slowly There must be no hurry for if exercises are done at the normal rate of breathing, the deeper respiration during the exercise will wash out the carbon dioxide from the blood which as you have seen is essential for the proper action of the mechanism controlling the blood vessels.

Keeping fit by running should also be done slowly first of all and it is far better to run a short distance, rest for a breather and then continue, than begin by hard and fast sprinting until exhausted. Personally I cannot see any value in this method of keeping fit, because, of all pursuits running *uses* additional

oxygen while it produces, *at the same time*, carbon dioxide and lactic acid, the products of waste and fatigue.

In all physical exercise circulation and respiration are closely related During exercise an athlete may require anything from ten to fifteen times the amount of oxygen which would be sufficient at rest In many athletic pursuits, notably rowing and cross-country running, the athlete will have to push his physical exertion to its fullest He will be 'flat out and will need a vast supply of food and oxygen, plus the ability to transport this in energy to his muscles and to be able to get rid of the accumulation of waste products which he has made, and will continue to make as long as the exertion lasts This is the basic relationship between the two systems

The importance of a properly functioning and sound heart is a matter of the highest importance It is in fact important to anyone, but in an athlete it is vital The output of the heart at rest is roughly 4–6 litres[1] of blood each minute. During a hard game of football or cross-country run or boxing match the output of blood in the heart may rise to anything from 15–24 litres per minute. The average during any muscular activity may be put at 20 litres per minute. The two factors which influence the output of the heart are (1) the output per beat and (2) the pulse rate It should be noted that the muscular heart of the physically fit athlete does not have to beat so fast as that of an untrained person *to produce the same output per minute*

During exercise the blood is viscid (glutinous or sticky) because of the loss of salts and water

After severe exercise there may be some acidosis in the blood and tissues This means that the blood has lost the alkaline reaction or a portion of it though it is not completely acid Many boat race crews have in fact shown a low acidity after a very exhausting race This is one of the most frequent causes of physical exhaustion and leads me to advise the salt habit in training I recommend a daily tonic of a pint of water to which has been added one teaspoonful of common salt, to all athletes in training I know from experience what it has done for many athletes besides having been of very great value during the war to troops fighting in the Far East I noted that the incidence of exhaustion from all forms of exercise,

[1] One litre equals 1 75 pints or 1 000 cubic centimetres (by capacity)

whether marching over rough country in the tropics, or training for athletics at home, diminished when the 'salt habit' was a daily occurrence, and from the experience gained I would recommend it without hesitation to all athletes This habit has become now a part of my daily routine, even though I no longer engage in arduous physical pursuits

CHAPTER VII

EXERCISE AND THE LYMPHATICS

WE have already noted in a previous chapter that the veins carry blood from the tissues, but these tissues also carry another fluid by a separate set of vessels which is known as LYMPH and the vessels which carry them are known as the LYMPHATICS (For fuller detail see glossary)

Lymph is a clear fluid, formed from tissue fluid originally derived from the blood, which has seeped through the walls of the capillaries This tissue fluid together with certain other substances, constitute Lymph Normally only the water of the blood together with the salts which have dissolved in it, can filter through the capillary walls, and the blood corpuscles and blood proteins are left behind If the capillaries are injured some of the protein also passes The tissue fluid is constantly being formed by filtration through the arterial ends of the capillaries [1] This is because the pressure in these vessels is higher than in the tissue spaces Normally it is just as easily and rapidly removed through the venous end[2] of the capillaries, where the blood pressure is lower and by the Lymphatics which carry it to the central Lymphatic channels Throughout the body there are frequent communications by which the Lymph may pass from the Lymphatics to the veins

It might be of special interest to understand what causes the fluid to return through the wall at the venous end of the capillary

The proteins of the blood plasma, by virtue of pressure, exert a kind of sucking action on the fluid in the tissues Normally this is counter balanced by the blood pressure in the arterial end of the capillary In this way filtration and not absorption results After heavy muscular exercise, or after injury, there may be some swelling partly from an escape of blood from ruptured vessels and partly as a result of the accumulation of tissue fluid in that area This accumulation takes

[1] Where the capillary is joined to an artery so that it is in fact a smaller channel of the artery

[2] Where the capillary enters the vein.

place because the injury, or the over-exertion, damages the capillary walls and these walls enlarge. While stretched filtration is increased and proteins force themselves into the tissue space and absorption is hindered

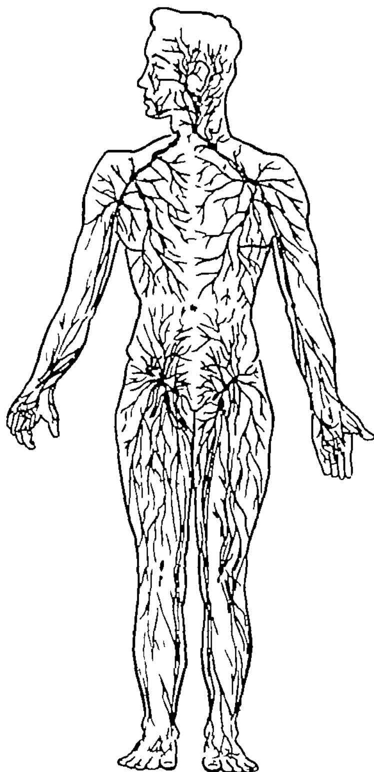
This protein eventually coagulates and forms strands of fibrous tissue which prevents normal movement. These strands are known as ADHESIONS and it is the break-down of these adhesions that is so necessary following injury or any signs of stiffness in the muscles following heavy exercise The ideal is to prevent their formation, and this should be the aim of all preparation for athletics Trainers should examine all muscular tissue and carefully feel, by palpation with their fingers, for any sign of fibrous tissue while an athlete is under their care from the beginning of training to the end

It can also be mentioned here that this sucking action of the proteins is of great importance in haemorrhage, for when the capillary pressure fails owing to loss of blood, filtration ceases while the proteins of the blood plasma continue to exert their action and draw the water from the tissues into the blood stream It can be seen that this assists in making up the volume of the blood.

Lymph has a number of functions to perform, perhaps the most important being to carry away all products of chemical change from the tissues. The more active the tissues, the more these products are produced. In such circumstances the flow of lymph is greatly increased because the increased blood pressure increases filtration from the capillaries and the products of chemical change attract water in much the same way as does common salt.

Lymph has a function in the intestines of carrying away some of the fat which has been absorbed from the digestive tract. The fat is added to the lymph by minute droplets, so that after we have eaten a fatty meal the lymph channels from the small intestine are full of a milk like fluid which is known as CHYLE These lymph channels join together and eventually empty into a receptacle from where the chyle is carried to the blood stream

It can be seen that lymph has many important functions and it is indeed the typical body fluid and is the basis of many other fluids of the body which we know by other names. Much the same process of filtration forms the fluid of the eyes tears, and urine and some lymph fluid is to be found in the joints



The main distribution of lymphatic glands and lymph channels

It can be understood from this that there is a resemblance between the physical process which causes the joints to fill with fluid, as will cause protein (such as albumen), to appear in the urine. Injury or the over exertion of a hard game with the consequent stretching of capillary walls may be the cause.

From the athletes' and the trainers' point of view it must be understood, then, that in order to stimulate absorption and tissue repair in injury the full power of the Lymphatics must be brought into play That is why we treat a part by gentle massage and gradually increase the degree and intensity of massage and stimulation until the joint function approaches normal To the trainer I would say—take special care of the lymph circulation in that region of the body most used by the athlete in his pursuit. If he is a runner, massage with long stroking movements the legs from the foot to the thigh, if he is a boxer, the hands, arms and shoulders in addition to the legs, and so on. Do not, of course, neglect the rest of the body but general massage will suffice for this Do not be afraid of causing a little pain in the later stages when you compress the lymphatics and squeeze away the waste You are sure to be told when you are too rough But never neglect the long firm stroking movements which help to keep the Lymphatic system alive and capable of doing its duty

CHAPTER VIII

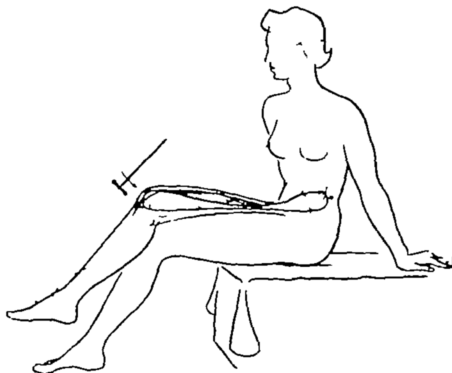
EXERCISE AND THE NERVOUS SYSTEM

THE function of the nervous system may be compared to that of a telephone exchange for it is concerned with the transmission of messages from one part of the body to another The central nervous system is really a sort of headquarters controlling the individual mechanisms which in their turn bring into play the circulation respiration and the muscles, so that there is a smooth all round relationship between them We have seen that at the beginning of a physical movement the initial impulse is received by the muscles from the brain In all competitive sports there is in addition, an emotional stimulus The flow of stimulant from the brain to the muscles is accompanied by a simultaneous flow from the brain to the centres of respiration and circulation. It can be implied that initial stimulus produces in the athlete a keenness and a general toning up feeling in the muscles There is also an increased supply of oxygen to the brain the heart the skin and the muscles The work of the nervous system in the athlete is just as important as the muscular system as it helps to produce the maximum amount of work with as little effort as possible. The well-trained athlete is well co-ordinated in mind and body and unless his work is unusually arduous he will not accumulate the products of fatigue so easily So that to completely train an athlete must develop not only his muscles, but all the other systems and co-ordinate them with his nervous system His energy should be muscular derived from normal nerve impulses and not the result of nervous energy

It must be understood that the nervous system works in two ways (1) Actions which are controlled by the brain, and (2) actions which are involuntary or reflex. For instance, if we take up a pen and wish to write a letter, we control the movements of the muscles of the arm and fingers in order that we may control the pen on the paper Then we think about what we wish to write, and do it The thought and the action is under our own will Of the reflex actions perhaps two are interesting

to the athlete and trainer and these are the Spinal Reflex and the Postural Reflex.

The Spinal Reflex Probably the simplest kind of reflex found in the body and is how the body protects itself from injury For example, if you prick your finger it is immediately drawn away from the point of injury If you are standing with your back to a hot fire you may quite suddenly jerk away because the heat is uncomfortable. These movements are quite independent of any conscious activity Indeed they occur in persons when they are asleep A very simple reflex jerk can be done by tapping the knee. The leg immediately jumps and the reason is that the impulse of the tap on the knee passes to the spinal cord and from there to the muscles concerned which contract, *thus causing the leg to jump This whole movement is known as* the reflex arc and it has a special importance because it can be ascertained that if the reflex is present the nervous arc on which the movement depends is intact, while if it is absent there is possibly an injury



Spinal reflex. An example of a typical reflex by tapping the knee is illustrated Note the movement of the leg upwards as shown in outline and the result of the stimulus to the brain and from there to the muscles involved

Postural Reflex Reflexes of this type maintain the balance of the body in spite of any degree or variety of movement By such reflexes walking and running is made possible. The weight of the body tends to bend the legs but in so doing some of the thigh muscles are stretched This stretching stimulates the nerve endings in them Impulses pass to the spinal cord and then to a portion of the brain known as the medulla, from which further impulses pass down to the muscles concerned causing a contraction in them Some of these impulses arise from the muscles, but in the maintenance of posture there are other impulses which are just as important These are impulses from the ear, which is divided into three sections, the outer, the middle and the inner In the inner ear (known as the vestibule) are two sets of small chambers which contain hair like processes from which hang tiny particles of chalk The bulk of these chalk granules sets up impulses which are responsible for keeping us informed of the position of the head in relation to the earth and also adjusts certain muscles so that the head is kept the right way up When these reactions are thrown out of gear by, say, a blow, we get giddy Many persons find it difficult to stand on one leg with closed eyes which is due to a lack of adjustment in these impulses.

The special importance to athletic trainers of the two reflexes discussed is that if there is an injury which shows an exaggeration of the reflexes, muscle tone may also be exaggerated There is in these instances a great danger that the muscles might waste Any injury to the head should have careful attention and special examination and a watch kept on the legs and thighs for muscle wastage.

Many reflexes become fixed as the result of experience. If you ring a bell and then feed a dog it is possible to observe that every time a dog hears a bell he will secrete saliva in anticipation of a meal The reaction becomes firmly implanted in the dog's nervous system. Many of our own reflexes become fixed by similar processes Any stimulation which gives rise to a certain response becomes fixed by repetition. It has been established that pain on movement may also become a habit For instance, if a person knows that a certain movement will cause pain that pain is still a conscious thing with that person even if the injury which caused the pain in the beginning is long past and the injury completely healed From the point of view of the trainer, it is very often difficult to instil into the athlete's

mind that no pain will occur and that movement must be encouraged This requires a psychological approach to the athlete on the part of the trainer and the complete cure of a case very often depends on it. Many athletes are highly strung and trainers will find cases in which there is justification for using this approach

CHAPTER IX

FOOD AND THE ATHLETE

THERE is no known or certain way of improving athletic performance by means of food, but the individual undergoing heavy muscular and physical exercise will have a greatly increased need for calories The purpose of this chapter is to discuss the nutrient requirements of the athlete

There are a very large number of foodstuffs from which an adequate diet can be chosen, but if they are to rank as foods they must contain one or more of the groups of materials known as nutrients. Some foods contain only one nutrient but most foods contain many In addition, water, and oxygen provided by the air are necessary to animal life, but they are not generally classified as nutrients

An adequate diet is one which will keep all the processes of the body such as growth maintenance and repair, at a high pitch of efficiency

The nutrients of which foods are composed are as follows (*a*) CARBOHYDRATES (*b*) FATS (*c*) PROTEINS (*d*) MINERAL SUBSTANCES and (*e*) VITAMINS AND OTHER ACCESSORY SUBSTANCES We will discuss these in more detail

Carbohydrates It is true to say that life is a chemical process and the body derives its energy and the material for its growth and maintenance from food A carbohydrate is a nutrient which provides the body with heat or other forms of energy In some circumstances carbohydrates may be converted into fat and stored in the body

There are three kinds of carbohydrates namely, sugars starches and cellulose and related materials The simplest of the sugars is *Glucose* and it is made from starch or by splitting the more complex sugars such as cane sugar It is found in the blood of animals while they are alive and in fruit and plant juices There is a great deal in sweet corn onions and unripe potatoes Another simple sugar is *Fructose* which can be changed into glucose It occurs in plant juices and in fruit and honey A chemical combination of glucose and fructose is *Sucrose* and this occurs naturally in cane and beet sugar in sweet fruits and

in carrots. Another combination of two sugars (one being glucose), is *Lactose* and it occurs in all kinds of milk. The last form of sugars is *Maltose* and this is formed naturally from starch during the germination period of grain

By far the largest proportion of carbohydrate in human food occurs as STARCH Starch is the form in which plants store the main part of their food reserves More than half the solid material in cereals and potatoes is made up of starch Unripe apples and bananas also contain starch which changes into sugar as the fruit ripens

Starch is composed of a large number of glucose units chemically combined In potatoes and flour the starch is enclosed in granules and as these granules cannot be digested when raw they must be heated in water which causes the granules to swell until they burst thus releasing the starch.

Much of the structure of cereals and vegetables is composed of *Cellulose* and although this group of substances is chemically composed of sugar molecules it is not very easily digested by human beings It forms a very small proportion of the day's food but it does have a value in giving a bulk to the diet.

It can be understood from the foregoing that there is a great similarity between sugars and starches though one would not think so from their taste When digested both become the same substance, glucose, and it is important to realize that all carbohydrates have to be converted into glucose before their value can be utilized by the body Fortunately the body does this very easily

All carbohydrates which are absorbed by the body serve the same purpose they contribute warmth or energy or are converted into fat. When choosing foods with regard to the proportions of different carbohydrates in them, it is not necessary to decide on the amounts of sugars starches or cellulose each food contains One must consider the *total carbohydrate which becomes available to the body* from the food you choose Except for sugar from the grocer and some others, all foods contain more than a single nutrient. Though wholewheat bread contains a large proportion of carbohydrate, it also contains substantial amounts of protein.

Let us see from what foods we can obtain the highest proportion of carbohydrates At the top there is of course, sugar syrup and jam while almost as much is contained in white flour oatmeal and bread Raisins dates and currants contain

a very high proportion, and the average of all these foods contain approximately sixty per cent carbohydrate

Potatoes and beans possess an important amount of carbohydrate, and so do bananas, grapes, apples, cherries, oranges and pears So you can see that a very substantial carbohydrate meal can be composed of very simple foods, such as bread and jam or syrup a handful of currants or raisins, and an apple, pear or banana

Some people have the idea that the sweeter the meal or food, the more beneficial it is, but this is not so Although sweetness is pleasant to the taste, there is no nutritional value in it Saccharin is sweet but it bears neither chemical nor nutritional relationship to sugar, and is, in fact, of no value to the body and is not, therefore, a food

Plants form sugar by the action of the sun on green leaves, and this sugar is stored in their stems, roots or seeds as *starch* When starch is heated it changes into *dextrin* and it is more soluble than starch though less so than sugar When bread is toasted dextrin is formed which makes the toast more digestible.

A variety of starch which exists in the body is known as GLYCOGEN and it is stored in the liver and muscles. It is turned into glucose by body ferments, and is the way in which the body stores its carbohydrate reserves for future use. After a big meal of carbohydrate the stores of glycogen in the body are increased, and after a hard spell of exercise the stored supplies of glycogen may become almost exhausted The amount of glycogen in most meat is very small since it becomes broken down after death of the animal Horsemeat is an exception, because you can taste the sweet flavour due to the amount of glycogen present in the horse being used very slowly during life.

It has been said that plants store fuel for energy in the form of starch. It can be stored by living things in the form of FAT and therefore fat is the most concentrated of all forms of energy foods Fats are not soluble in water, but require liquids such as petrol ether or chloroform to dissolve them. These liquids are called fat solvents which like fats, will not mix with water Fats are derived not only from meat, but butter and oils derived from vegetable or animal sources *All common fats possess the same value as food* The physical quality of fats varies because some of them liquify at lower temperatures than others Oils are therefore fats which remain liquids at ordinary

atmospheric temperatures but if they are cooled they become solid

In plants, fats are formed from carbohydrate When seeds ripen, the amount of starch falls as the amount of fat increases Oil seeds such as linseed or cotton seed are among the most important sources of fat for making margarine. In animals fat may be formed from carbohydrate. If an individual eats more starchy food than he needs for his physical output, fat is laid down Besides forming fat from carbohydrate, animals can also deposit in their bodies some of the fat from their food. It is possible to split fats into glycerol and soap both of which can be dissolved in water The process of splitting fats into glycerol and soaps is known as *saponification*,[1] and all fats which are useful to the body as food can be saponified. Mineral oils, such as liquid paraffin or greases such as vaseline, cannot be saponified, so that they are not classified as foods, being unavailable to the body for the production of energy

Foods which provide fats in the diet are, of course, butter, margarine, dripping and olive oil They are the highest with approximately eighty to one hundred per cent. (Olive oil and cotton seed oil contains for instance one hundred per cent.) Nuts contain varying amounts from coconuts, peanuts almonds and brazil nuts, but all in excess of forty per cent. Brazil nuts contain as much as sixty five per cent fat. Bacon and cheese contain large proportions but mutton and beef are lower in fat content. Of fish, herring contains the most, with salmon a good second Eggs and milk also contain an appreciable amount Vegetables and fruits contain almost no fat at all and of flour and other cereal products oatmeal is the only one which contains any amount but this is of practically no consequence as food Fish such as eel herrings salmon, mackerel pilchards and sardines are called Fat Fish, because of the amount of fat contained while cod whiting sole and haddock are known as White Fish, because of the little fat in them. Therefore a good satisfying meal containing all the necessary fat might consist of a herring or piece of salmon, some milk and a few nuts Alternatively bacon or beef or cheese may be the main constituent, with milk and nuts to follow A simple satisfying meal can be easily made up on a cold day for any athlete in training from the foregoing

The essential substance of living tissue is known as PROTEIN

[1]The conversion of fat or oil into soap

It is the essential substance of all plant and animal cells and there is no known life without it In animals as in man, the muscular tissue of the body is made up of protein It therefore follows that protein is needed in nutrition for the growth and repair of the human body

As the muscular tissue of animals, that is, the lean meat, is composed of protein, it serves to provide the main source of protein as a nutrient for the human diet.

Protein in the diet is used for two main purposes it is necessary for growth and repair of the body, and for the production of heat and energy The protein structure found in the human body differs very much from that found in plants and in animals The two sources of protein for nutrition are *Animal Protein* and *Vegetable Protein* Of the former, it is found in meat and fish of all kinds, poultry, game, shell fish, milk, cheese and eggs. In vegetables, protein is found in potatoes, peas and beans (these are the highest yielders of protein in vegetable life), cereals, such as wheat, rice etc and nuts Root vegetables contain a large percentage of water, therefore their protein content is low Green vegetables contain a small proportion also If protein is derived from vegetable sources, a vast amount must be eaten so that the body is able to take them to pieces and put them together again in the form most suitable to supply the needs of human muscle If the protein is derived from animal sources much less is needed, since the degree of difference between human and animal protein is less than the difference between human and vegetable protein. That is why we call the protein derived from animals a first-class protein, while that derived from vegetables is called a second class protein. It is interesting to note that there will be always a little protein left over spare from normal diet, after the body uses what it needs for growth and repair, and this is used for energy or heat It can be seen that protein is equally useful for providing energy for the body as well as carbohydrate, but although protein does provide the body with energy its first and foremost duty is to provide growth and repair, *and no other nutrient can act as a substitute*

The foods which provide protein are principally as follows

Of animal protein beef mutton, eggs, milk, and cheese

Of vegetable protein beans flour, potato spinach pea nuts and cabbage, carrots and turnips

It has already been explained that the principal uses of

food is to supply energy and heat to the living body It has also been explained that of the three necessary and most important nutrients namely, carbohydrates, fats and proteins these together will give the body the total energy and heat it needs to maintain and balance it But there are two other forms of nutrients which we can now discuss and the first are the ESSENTIAL MINERAL SUBSTANCES, for the body, to possess a well-balanced diet must contain many of these Most of these mineral substances are derived from the food we eat. As the body loses sweat following exercise, it loses salt. It is one of the most essential minerals of the body A shortage of salt will cause severe cramp and that is one reason why I specify the salt habit already referred to in an earlier chapter There is no control in the amount of salt lost in sweat during heavy exercise, so that it is better to take more than we need because the excess the body does not need is harmlessly passed out in the urine Salt is found in cheese, kippers, bacon, bread, fish meat and most vegetables Another important mineral is iron, for a sound circulation is dependent on the haemoglobin of the red blood corpuscles. The substance which gives the blood its red colour is built up on a basis of the metal iron. This iron must, in the first instance, be derived from food An essential diet must, therefore, contain sufficient iron. Once iron is absorbed by the body it is lost very slowly Actually it is the red blood corpuscles which contain the iron, and as the life of each corpuscle is comparatively short (about six weeks) the corpuscle breaks up and releases the iron It does not escape from the body, however but is used again for the formation of fresh corpuscles These new blood cells are produced as has already been noted, in the marrow of the bones In spite of the fact that iron is used *over and over again it may be lost from the body by general* wear and tear and the remains of the digestive juices passed out of the body and of course, whenever bleeding occurs If there is insufficient iron in the blood a disease called anaemia will occur Small amounts of iron are contained in water used for drinking and cooking and from kitchen utensils and cooking pots The foods which contain iron are liver and kidney beef eggs raisins, fish, milk and watercress and cabbage

Calcium phosphorus and magnesium are equally essential minerals of diet. Since magnesium is found in practically every type of food there is no chance of the diet being short of it. The bones and teeth contain quantities of calcium and phos

phorus, and for efficiency there must be a greater proportion of calcium

Calcium is necessary for proper formation of the bones and teeth It is essential for the proper clotting of blood and the normal functioning of muscles Just as a shortage of salt will cause muscular cramp, so will a shortage of calcium A shortage of calcium is one of the commonest faults in nutrition A source of calcium is hard' drinking water, cheese, milk, eggs, water cress, and fish. Very probably the rheumatic pains in joints may be due to the constant drain of calcium While this occurs in the adult, a shortage of calcium in children will stunt growth and cause rickets

Phosphorus is used by the body for a number of vital purposes It is a major constituent in bones and teeth, and plays an important part in the processes by which the body obtains the release of energy from food The body also has to maintain a certain constancy in the composition of its fluids which is necessary for life to continue and phosphorus is important in this function as well In addition, phosphorus is concerned in the life and structure of all the cells of the body Luckily, most foods contain phosphorus in some proportion, particularly, fish, kidney, liver, meat vegetables and fruit Milk and cheese contain phosphorus as well as calcium, but the proportion of calcium is greater An interesting point is that phosphorus is concerned with the functioning of the cells of the brain It was thought by many that as fish contains a large percentage of phosphorus that it might be a brain food Actually this is not so as the brain itself contains more of the mineral than does fish For that matter the greatest percentage of phosphorus in food is contained in sweetbread kidney and liver so that if any foods are to be called brain foods these obviously must have a prior claim

Small quantities of Iodine are necessary in the body for it is a substance found in the thyroid gland which plays an important part in controlling the rate at which energy is used up Iodine is found in drinking water sea fish oysters certain vegetables, especially watercress and onions A shortage of iodine can be easily made up by using iodized salt for cooking and table use

The Importance of Vitamins

Artificially prepared foods, although they may contain most

of the necessary nutrients for fuel and tissue repair may not maintain the body in perfect health Certain other substances are necessary and are recognized as essential adjuncts to a full diet These substances are known as *Vitamins* and the human body cannot make them for itself When a dog goes scavenging it is not usually for the pleasure he gets from the pursuit. Generally there is a deficiency in his diet, some chemical substance which he may find either by chewing the grass or poking his nose in a dustbin. Luckily the human being finds his vitamins in an easier manner We will deal with the principal vitamins.

Vitamin A This is a substance which is found in certain fatty foods and in some fats It serves several functions—it is essential for the growth of the young it protects the skin and mucous such as the lining of the respiratory tract, throat and bronchial tubes and it plays a very important part in the ways the eyes see light. The most concentrated sources of vitamin A are fish liver oils. All dairy products contain it, milk, cheese and butter and eggs. The amount of vitamin in green vegetables is solely dependent on their greenness Dark green vegetables such as watercress, contain larger amounts of vitamin A than paler vegetables such as cabbage. In carrots the yellower they are the more vitamin they contain. The body can store vitamin A in the liver so that if a large amount is eaten say in the late summer and autumn, it may be sufficient to provide enough vitamin A for the body for the best part of the winter The vitamin obtainable from animal foods is of much greater value to the body than that obtained from vegetable sources

Vitamin B This is really a group of vitamins but for the purpose of this description it will be dealt with as one vitamin so as to avoid confusion The main function of the vitamin is to form part of the machinery which provides a steady and continuous release of carbohydrate energy If insufficient vitamin B is provided in any diet there is a check in the growth in the young the development of skin irritations many digestive complaints, and it brings with it a type of neuritis Usually the individual becomes irritable depressed and nervy and is apt to be quarrelsome. Vitamin B is found extensively in brewers yeast, and is found in almost every form of diet, except in white bread and sugar Among the best everyday sources are dairy produce, eggs and liver but sufficient proportions will be

found in kidney, cheese, bacon, meat extract, peanuts and oatmeal

Vitamin C This is found in fresh fruits and vegetables, but especially in oranges, lemons and black-currants Brussels sprouts, cauliflower, cabbage and watercress contain a fair proportion also If the human diet does not contain vitamin C health will suffer and will show itself in a susceptibility to infection, wounds and fractures are slower to heal, and in the final result a disease known as scurvy may become evident

Vitamin D This is a substance which is concerned in the laying down of calcium and phosphorus in bones It is of special importance in young athletes and is derived from foods and sunlight. Of foods it is plentiful in cod liver oil, but sardines herrings tinned salmon and eggs also contain it It is vital for all young people whose bones are still in process of forming, and in the adult a deficiency will cause a disease of the bones similar to rickets in children Sunlight acting on the skin causes the manufacture of a substance called *Ergosterol* which assists in the formation of vitamin D so that controlled radiations with ultra violet light is extremely beneficial in the production of this vitamin It can be found in glucose sold in chemists shops which contains *calciferol* and this can be added to fruit drinks or tea

Now that we have thoroughly discussed the different foods and their importance to the athlete it might be well to discuss the relationship between this food consumption and exercise We have seen that one of the main reasons why we need food is to supply energy to the living body The energy value of food is measured in terms of heat and is known as *Calories* Strictly speaking the term used in nutrition is known as a 'large calorie (C) to distinguish it from the small calorie used in physics The Calorie is the amount of heat needed to raise the temperature of 1 000 grams of water 1 degree Centigrade For energy purposes we know that

One gram of carbohydrate absorbed by the body will produce four calories one gram of fat will produce nine calories, and one gram of protein will produce four calories

From this it will be seen that the energy producing value of any food can be calculated For instance if we know that wholemeal bread contains thirteen grams of carbohydrate, 0 5 grams of fat and 2 5 grams of protein per ounce, the energy value of one ounce of wholemeal bread will be calculated to

produce 13×4, plus 0 5×9, plus 2 5×4, which equals 66 5 calories

The calorie value of all foods is determined from the amount of nutrients in them so that watery foods such as lettuce or soup will contain very little energy producing material On the other hand, foods rich in fat will produce the highest calorie value Of the highest calorie producing foods cooking fat, butter, bacon and cheese are the most important, while sugar, beef bread and dates follow Other important foods are potatoes, bananas, milk and apples, while cabbage, turnips and beer will produce only small amounts of energy I mention beer[1] because of the value placed on it by certain athletes of my acquaintance, but actually it is among the lowest forms of energy producing foods The energy value of meat depends on the amount of fat it contains, but all meat produces energy

The amount of energy used by individuals depends on their size so that in general men will need more calories than women. Calories are needed whether the individual is at rest or not and the number of calories produced during rest is known as the BASAL METABOLIC RATE or BASAL METABOLISM This figure is approximately 1 600 per day and this may increase during active physical exercise to 4,000–5 000 while amounts of 10 000 are not unknown in arduous exertion

All food taken by the athlete should consist of sufficient calories to maintain the body weight during the entire season Weight of the body will depend on the size and structure of the body surface, but it will vary with the number of calories taken and the amount of exercise undertaken If you take in more calories than you require you get fat, if insufficient are taken you get thin. Each individual varies in the Metabolic Rate and in the extent to which protein intake stimulates his Metabolism, for protein in addition to other qualities appears to act in the body as a current of air does in a fire. Thus if a person is losing weight the taking of protein instead of carbohydrate is an advantage. If on the other hand you wish to increase weight you should concentrate on carbohydrate diets instead of proteins It can be demonstrated that if a diet consists solely of vegetable products that is apart from cereals and peas and beans weight is rapidly lost. The reason is this—vegetables are

[1]Note A pint of beer will produce 160 calories, whereas a pint of milk will produce 360 calories.

not easily digested by man and so in reality little nourishment is derived from them It must be emphasized that if additional exercise is undertaken in order to reduce weight it should be sufficient to produce slight breathlessness and should not be followed by large meals consisting of carbohydrates On no account should the athlete try to reduce weight by taking drugs because there is always a danger to the heart by this method

All athletes should weigh themselves regularly, commencing about ten to fourteen days after training starts and at weekly intervals These weighings-in should be done at the same time on the same day of each week and on the same scales

Food requirements generally may be gauged as follows

Protein	approximately	15	per cent
Fats	,,	40	,,
Carbohydrates	,,	45	,,

and if these figures are studied, well balanced meals may easily be prepared which will provide sufficient heat and energy and reserves To help further I have prepared a table of the main foods showing their composition

No athlete should take a heavy meal prior to any athletic pursuit or game The ideal is a satisfying but light meal about two hours before the advertised time to start The reason for this is simple, as during exercise the circulation diverts its energies to the muscles heart and brain

During training periods hours of meals should be regular, and the amount taken should depend on the amount of exercise involved This assures adequate reserves and maintains the body weight Since the metabolic rate during exercise is high, periods of rest are as important as food For the individual it is difficult to lay down fixed periods of sleep for his own common sense will tell him, but often trainers are faced with one or two energetic members of a team who never feel the need for rest In training a group of individuals every trainer must fix rules and regulations for the amount of rest and the times of each period A short hour of quiet rest in the middle of a strenuous training period is very often the prevention of staleness in many an athlete.

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[1]Note: A pint of beer will produce 160 calories, whereas a pint of milk will produce 360 calories.

From eight to nine hours of sleep in every twenty four are necessary to maintain the body standard of the athlete in training The importance of rest and quiet during training cannot be too strongly emphasized, as one of the first signs of staleness or break-down in an athlete is his inability to sleep This is usually partly nervous, partly emotional and partly physical fatigue It must always be realized that the main function of the development of the athlete is to ensure the production of a maximum of muscular energy with a minimum of effort, and in this the complete co-ordination of four essential parts of the body is brought into the picture namely, the muscles, the heart, the lungs, and the brain If we wish, there fore, to maintain an ideal body weight, good reserves of energy and a calm state of mind to approach our work and give of our best, proper food intake and rest are essential

From observations I have made during the past twenty years I have found that the average athlete needs approxi mately 4,500 calories daily (this varies, of course, in the size of the athlete and the sex, but is seldom less than 3 800) and meals should be prepared to possess round about this figure. Many athletes find that a hot meal is more stimulating and satisfying than a cold one but the difference of calories in the former is not enough to make much difference. However, the intake of a pint of hot soup following exercise will be beneficial and in addition to the calories provided in the nutrient of the soup a small amount extra will be taken, in the heat of the soup It will certainly be welcome to a cold exhausted athlete after a hard cross-country run. Some athletes of my acquaintance find it impossible to acquire the salt habit, and in many cases I have advised *chewing Bemax tablets just before a game* or athletic event About six of the tablets chewed like sweets seems to have a sedative effect on the nerves and calms the emotional disturbance which many athletes have Certainly whatever other benefit is derived it is a safe and pleasant way of ass milating vitamin B Up to twelve tablets in a day are quite safe.

A question often asked by athletes is how they may know whether they are getting a sufficient diet. One well known athlete actually asked me not so long ago just how he could know whether he was deficient of calories I found that although his performance in athletics had not suffered he was always hungry A shortage of calories will always be felt as

General Table Showing the Composition of Food

The Values of all food nutrients are shown in grammes per edible ounce thus—1 oz of beef (fresh) would provide as follows

88 calories 4 grammes of protein per ounce 8 grammes of fat per ounce, and no carbohydrate [1] Nearly all the foodstuffs shown in the table show a trace of mineral salts and vitamins

The table is by no means exhaustive but is intended to furnish a guide to the nourishment obtainable from different types of foods.

FOODSTUFF	CALORIES	PROTEINS	FATS	CARBO-HYDRATES
		gr	gr	gr (i.e. 31 grs. = approx 1 oz.)
Beef (fresh)	88	4	8	—
Liver (ox)	40	5	1.5	1.5
Pork	117	3.5	11.5	—
Bacon	129	3	13	—
Corned beef	69	7	4.5	—
Shepherd's pie	34	2	1.5	3
Other meat pies	125	2	8	10.5
Potatoes	24	1	—	5
Peas (fresh) green	20	2	—	3
Beans (canned baked)	26	2	—	4.5
Beans (haricot)	72	6	—	12
Cabbage	6	0.5	—	1
Carrot	8	0.5	—	1.5
Lentils	84	7	—	14
Apple	12	0.1	—	3
Orange	10	0.2	—	2.5
Raisin	67	0.3	—	16.5
Peanut	157	7	13	3
Chocolate	147	1.5	9	15
Sugar	108	—	—	27
Honey	78	0.1	—	19.5
Beer	2	0.1	—	0.5
Cocoa (with milk and sugar)	11	0.5	0.6	1
Tea (with milk and sugar)	2	A trace of each		
Bread (National)	71	2.5	0.5	14
Bread (wholemeal)	71	2.5	0.5	14
Biscuits (sweet)	139	2	7	17
Wheatflakes	91	4	1	19
Rice	96	2	0.3	22
Oatmeal	111	3	2.5	19
Butter	207	0.1	23	—
Cheese	118	7	10	—
Egg (fresh)	41	3.5	3	0.3
Milk	18	1	1	1.3
White fish	21	4.5	0.3	—
Herring	48	4.5	3.3	—
Sardine	87	6	7	—

[1] The calorific values shown are to the nearest whole number

substantial quantities of carbohydrate, together with vitamins and minerals When large amounts of potatoes are eaten, substantial amounts of calories are obtained Green peas and broad beans contain more calories and more protein than any other vegetable They also contain vitamins A and C Nuts and fruits are highly nutritious and contain between them protein and fats, vitamins and minerals They are therefore substantial providers of calories

Before closing this chapter I might mention two points No athlete should do any exercise before taking a meal at the beginning of the day, as the efficiency of the muscles is at its lowest It is good sense, besides being sound nutritional practice, to start the day with a satisfying meal and then go on to training, following this with a rest for an hour or two The second point is that no athlete should be forced to eat what he definitely dislikes on the grounds that it will do him good It is my experience that it is what you like in food that does you good providing there is enough of it. And a sufficient variety exists to make this sure

hunger and though the body will take some time to show this shortage, as probably the shortage was one of animal protein nevertheless the shortage is there, and must be made up Therefore it may be safe to state that for the athlete, an adequate diet is one in which there is *as wide a variety as possible of natural foods* Single deficiency of a nutrient is more common than a shortage of several nutrients or minerals or vitamins so that the correct treatment is to provide a diet fully adequate in *all nutrients* For this reason I will describe some details of the composition of food in terms of nutrients

Of all foods, probably milk is the most complete There is, however a deficiency of iron and vitamin C (even the small quantity present is destroyed by boiling) but this can be made up in other foods Milk contains about four per cent protein 3 5 per cent fats and four per cent carbohydrate (lactose),[1] and water Of the rest of dairy produce, cheese, butter and cream and eggs, are very nutritious foods and possess in addition vitamins A, B and D There is also some fat and calcium. All dairy foods should be high on the list.

Meat is another high source of nourishment, and perhaps it ought to be mentioned that the expensive cuts are not necessarily more nutritious than the cheaper cuts. Meat contains protein and many of the mineral salts and some fats. Liver is a good source of vitamin A and iron.

Fish contains protein and fat practically no carbohydrate, but varying quantities of mineral substances and vitamins (except vitamin C)

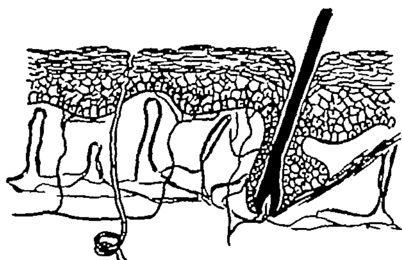
All the common cereals are prolific sources of carbohydrate. Oats contain about sixty per cent carbohydrate and thirteen per cent protein and rice has eighty per cent carbohydrate and about seven per cent protein. Therefore oatmeal and rice pudding are very valuable foods If oatmeal is taken as porridge it should be accompanied with quantities of milk as oatmeal contains a substance called phytin which interferes with the absorption of calcium. Milk is taken to neutralize the phytin substance. Bread contains carbohydrate some iron, vitamin B and a little fat.

Green vegetables contain vitamins A and C, but provide few calories There is only a small trace of protein and fat They are bulky foods and generally prove indigestible to the athlete. Root vegetables such as potatoes carrots turnips and swedes are more important as foods and contain a trace of protein

[1] Lactose = Milk sugar

body, for actually it is an important organ having a number of functions For instance it helps to regulate the temperature of the body by evaporation of sweat

It should be the first among the many duties of the athlete in preparing his body, to look after his skin so that it may do its work efficiently The skin should be as fit as the rest of the body Irritation and friction must be reduced to a minimum and it should possess just as good a tone as muscle itself It must also have an efficient blood supply and be shed of all dead skin wherever it appears. If corns and callosities appear on the feet then a visit to the chiropodist is necessary Nails must be cut carefully and ingrown corners removed Debris must be removed from under the nails, with an orange stick and a solution



Simple drawing of the skin showing layers and hair follicle (shown thickly) together with sweat ducts and a blood capillary loop

of hydrogen peroxide. Dip the orange stick into the solution and clear all debris from the nail endings and cuticle. Dry carefully between the toes and see that there are no cracks

It is better to avoid using any irritant lubricant when massaging the skin as the friction may reduce the superficial cells too rapidly and abrasions will be easily caused A mild bland lotion is much more suitable, and a very useful one which I have found beneficial is a mixture of equal parts of surgical spirit and glycerine This is best used when the skin is still wet following a bath or shower and the mixture can then be slowly massaged into the skin leaving it soft and pliable and in good tone. After it is dried with a soft towel a sense of well being

CHAPTER X

IMPORTANCE OF THE SKIN

THE surface of the body is protected by skin which consists of layers of epithelial[1] cells which constantly die and are constantly replaced The growth takes place in the deeper layers which consist of polygon[2] cells but they become flattened as they reach the surface The superficial layers are scales of cornified cells which have become hardened before being shed. These superficial cells are very liable to be removed rapidly by too frequent massage or by irritation with a strong rubbing solution. The surface layer of the skin with which we are most concerned *is the outermost layer, which is known as the* epidermis

Skin contains blood and nerve endings and in one of the lower layers is a net work of capillaries which act as a storehouse for blood and this gives the skin its normal colour When blood is withdrawn from these capillaries by either shock or severe bleeding the skin becomes pale These capillaries are very important and if massage is to be of any benefit they must be gently shaken and squeezed so as to increase the supply of blood to the skin You may notice that if a person is bedridden for a long period bed sores will occur as a result of the compression of the skin capillaries and lack of nourishment from the blood reaching the skin

You will notice that the skin is usually soft and pliable and this is caused by the action of glands between the cells which secrete the fatty substances and release a portion at intervals. Nerve fibres in the skin are responsible for giving you the sense of touch and pain and enables you to tell the difference between hot and cold objects If the skin is blistered the nerve endings may become exposed and sensation is increased. An exposed nerve ending is very sensitive to any change and therefore a break in the skin should be kept covered until granulation (knitting together of the skin) takes place.

The skin must not be considered only as a covering of the

[1] Cellular substance of the skin and mucous membrane
[2] Polygon—many sided.

CHAPTER XI

PHYSICAL FITNESS, WITH SOME GENERAL EXERCISES

THE subject of physical fitness has been one of absorbing interest for centuries The Greeks Romans and Egyptians all spent many hours of every day trying to find the secret of bodily health, and they engaged in athletic pursuits of a very arduous character In fact the literature of all these peoples abound with stories of chariot races, marathon races, wrestling and javelin throwing to name but a few In my opinion and experience there is more controversy around the subject of physical fitness than possibly any other topic that appeals to the athlete or the follower of sports

There is no real answer to the question ' What is physical fitness? for obviously the answer must depend on fitness for what. It must depend on the task in hand Differing athletics and sports require differing methods of acquiring fitness The marathon runner finds little difficulty in completing a twenty six mile course without undue effort and exhaustion I have a coalman who has delivered sacks of coal to my house for over twenty five years He is an elderly decrepit gentleman yet for years he has been attuned to this physical task without any training whatever If the marathon runner and the coalman were to change places who, you may well ask would be fit for what? We are constantly pressing on towards trying to understand the human body and its complex mechanisms which are involved in muscular effort and exercise

It is perhaps only in recent years that we have been near to understanding all the factors involved which can give us a clear picture of physical effort How then, can we define physical fitness? Is it merely a state of muscular energy muscular bulk or muscular strength? It is of course all these and something more

Physical fitness is in my opinion the development of the body *and* mind to such a pitch of condition that a given amount of physical work can be produced *as and when desired* with a minimum of physical effort The impression that physical

is experienced and this simple method is also a good manner to set the skin up, by increasing circulation, and so avoid catching cold or chills. Many athletes are prone to these chills and often stomach cramps are experienced on a cold day after one has changed from outdoor clothes into athletic kit. This can be prevented by the method described and the region of the stomach can also be protected by a windcheck made up of simple sheets of stockinette secured by one or two pieces of plaster This has been found to be extremely valuable to cyclists, cross-country runners oarsmen and footballers It is often a habit to shave all superfluous hair off the thighs and legs, but in my experience this is a bad habit which I would not advise. Constantly shaving destroys the cells in these parts and the protection of not only the cellular efficiency but of the hair growth itself is lost. Many athletes have told me that it is intended to increase performances by this method but I have yet to have it proved I do not believe that it can or will increase either the speed or performance of any athlete but on the contrary will certainly reduce the tone of the skin by too rapid destruction of its cells

Heavy oils and greases are not particularly good for the skin as they block the sweat glands and leave a thick layer of uncomfortable matter on the surface of the skin which attracts dirt, dust and insects. On a hot day it is especially annoying The skin should be kept as dry as possible and any oil or lubricant used should be one that the skin can absorb Excess should be wiped off with cotton wool or a soft towel

All blemishes abrasions and cuts must be cleansed and protected Grit which finds its way into the skin must be washed out and a bland ointment such as lanoline applied or painted with friar s balsam, after which it can be covered with a small dressing

To sum up no area which can be the seat of infection should be neglected The inner parts of the thighs which often become chapped can be easily protected with a light dressing of Fullers Earth cream and covered with a plaster dressing The same treatment can be used for cracks at the tips of the fingers Examine the skin daily for anything unusual and apply preventative measures, for remember it is an organ and must be made to work like one It is not true to say that if you look after the inside of your body the outside will look after itself Look after both and make sure of their efficiency

No individual likes another prying into his affairs, but the more information the trainer knows about the athlete's home life, girl friends, mental stresses, and the ability to recover from emotional disturbances, the more able is the trainer to decide whether the athlete is fit in the full sense of the word, or whether a team would be complete that included him Sentiment has no part in modern athletics and the athlete is either all fit or he is not fit at all.

As we refer to it today, physical fitness has only one interpretation which is fitness for strenuous games and athletics There are many tests, some simple and others complicated, which can provide an index of bodily fitness for exertion, but a player might be found to pass all these tests, and not have the temperament called for I mentioned earlier in this volume that a man's nervous system has to be as fit as his muscles, because both are important in producing the maximum amount of work with the minimum amount of effort To the player it is only necessary to say that his physical output will depend on his mental and physical input. In other words he will only take out of any pastime just what he is prepared to put into it. If the whole co-ordinating machine is functioning he is more likely to be a good athlete than a bad one To the trainer it might be said, you are in the best position to say what the athlete is likely to give. Watch your men and manage them. If they know you are on their side you are much more likely to get what you want from them and what your team will need, fully trained and co-ordinated athletes, and no trainer can ask more than that

The following exercises are intended in the nature of limbering and general toning up Further reference will be made to other exercises in a later chapter, but meanwhile the athlete, especially the young one, will find these simple exercises of great value and will help him to proceed to more strenuous ones They can, of course, be included in any training programme alongside with any others but should facilities or more involved exercises not be available, say for boys clubs or youth hostels they will be found to contain all the necessary movements for maintaining the efficiency of the young body They will also be found to be just as suitable for girls and women athletes as men and boys

fitness only concerns the muscular system is erroneous. The efficiency of the muscles and physical effort thereby depends on a perfect co-ordination of muscle, respiration, and circulation, superintended, so to speak, by the nervous system.

The individual, to attain a pitch of muscular activity must without a doubt develop his skeletal muscles which are necessary for the production of energy but he must also develop *to the same degree of efficiency* the circulatory and respiratory *systems which provide these muscles with food and oxygen* and remove the waste products, and at the same time the nervous system by which these processes are co-ordinated The athlete must be fully toned physically and mentally and attack life with a sense of well being unconscious of obstacles, and devoid of any sense of emotion which a sports crowd is only too eager to impart to him One has to have the mind to recognize only the task imposed and be tuned for this alone The mind must be logical and reasoned and if the co-ordination is proper and complete the athlete will know fully well that the task is not beyond him.

Physical fitness for a given task depends upon the physical equipment and the competence of the individual to meet the stress of such a task. There is also the psychological factor to be taken into account. Every athlete has a measure of motivation, the spirit which drives him on to fulfil his task. So that you can see that physical fitness is not just an anatomical idea of bodily perfection It is *completely* functional, and embraces physical *and* psychological factors which cannot and should not be separated. You cannot take the spirit out of the athlete and leave him only his physical ability For then he is not fit at all only his muscles are fit and what good are these without the driving force of his psyche his inner self? It is important that every athletic trainer must be able to measure the functional capacity of each athlete in his charge and to assess the individual *degree of motivation in each person. He can then put the two* factors together and produce a fully trained athlete.

Physical fitness is more often governed by psychological factors than is realized and any disturbance of mind will often completely over shadow the physical competence of the body It is the trainer's duty to examine the state of mind of the athlete and by careful observation of habits and general behaviour it is not difficult for the trainer to become the father and the confessor of his charges.

GENERAL EXERCISES FOR FITNESS

IT is true to say that inactivity leads eventually to deterioration and that the more we have to do the more we like it, and the better we are able to do it

I have already stated more than once that the human body is very like an internal combustion engine, and if the parts of the machine are improperly tempered, or if grit gets in among the parts, these break down.

The internal organs are vitally important and are affected by movements which at first seem to be merely for the outside of the body We should therefore, take great care of such things, we should take even more care to ensure that our various organs are treated properly so that they will work well It can be compared to the cleansing of dirty petrol and oil from the engine The motor can then run sweetly and efficiently

Keeping fit involves all the organs of the body if we are to have life and have it abundantly in order to do the work we have to do

The following exercises aim at making the tissues healthy so that proper function takes place. They are designed specially for the young athlete with little facility for large scale gymnastics such as youth clubs schoolboys and schoolgirls though they will do equally well for the large participator in sport generally

A convenient rhythm must be adopted for all exercises and throughout the movements the breathing should be free and unrestricted and through the nose, during both inspiration and expiration

Every exercise has a beginning and an end and it is necessary to show both these clearly

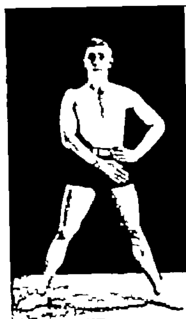

Fig 3


Fig 4

EXERCISE 3

Start as in Fig 5

1 Lift the chest keeping the chin in and turn the palms upwards at the same time breathing in (Fig 6)

2 Return to first position breathe out

Repeat six times and finish in standing position.

EFFECTS.

This exercise stretches the muscles of the chest and develops those of the back.

The movement of the ribs facilitates breathing

The upper part of the spine is straightened and the movement is corrective for round shoulders

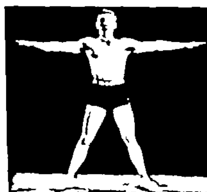

Fig 5


Fig 6

EXERCISE 1

Start as in Fig 1

1 Bend the left knee swing arms apart and turn head to left (Fig 2)
2 Stretch left knee swing arms forward and turn head to front.
3 Bend right knee swing arms apart and turn head to right
4. Stretch right knee swing arms forward and turn head to front.

Repeat six times and finish in standing position

NOTE Keep feet still.



Fig 1



Fig 2.

EFFECTS

This exercise strengthens the ankle knee and hip joints together with the muscles of the calf thigh and hip

The arm swinging draws the shoulder blades back and expands the upper chest

The head turning makes the neck supple and strong

The general carriage of the body is improved and a lively circulation *of blood is set up*

EXERCISE 2

Start as in Fig 3

1 Turn trunk to the right and swing right arm obliquely upward looking up to hand (Fig 4)

2 3 and 4. Repeat movement three times and change.

5 to 8 Repeat to opposite side.

Repeat six times left and right and finish in standing position.

NOTE Keep feet still and knees straight.

EFFECTS

This exercise improves the muscles of the waist chest and spine.

Digestion and excretion are assisted and breathing is improved by the increasing action of the ribs.

The arm movement helps to correct the carriage of the shoulder blades.

EFFECTS
Relaxing

To shorten a muscle you send it a nerve message to keep it tense you go on sending more. If you are always slightly tensed you are wasting energy

Practise relaxing all your body from face to feet once a day Also during the day, relax one part at a time wrist, shoulder ankle, etc.



Fig 9 (above) Fig 10 (below)

EXERCISE 6

Start as in Fig 9

Hop on the right foot and swing left leg sideways (Fig 10) Change and hop on the left foot and swing right leg sideways.

Repeat six times finishing in standing position

If inconvenient omit hopping and swing leg sideways whilst raising heel of standing foot

EFFECTS

This exercise is useful to counteract flat feet

It strengthens and develops the muscles on the outer and inner side of the legs It improves the structure and suppleness of the hip joints and develops the insteps.

Owing to the large muscle groups involved it stimulates circulation and breathing and is invigorating

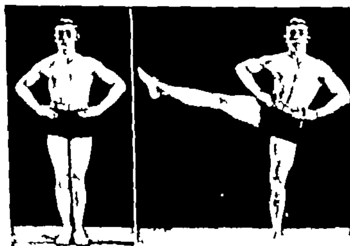


Fig 11 Fig 12.

EXERCISE 4.

Start as in Fig 7

1 Bend trunk forward and downward and stretch the arms hands to floor keep knees straight (Fig 8)
2 Stretch the trunk upward and bend arms as in Fig 7
3 Stretch arms upward
4 Bend arms (Fig 7)
Repeat six times and finish in standing position

EFFECTS.

Trunk bending forward compresses the contents of the abdomen and affects their circulation

In this way it aids digestion and excretion

The arm movement develops the arms shoulders, chest and back and improves their joints

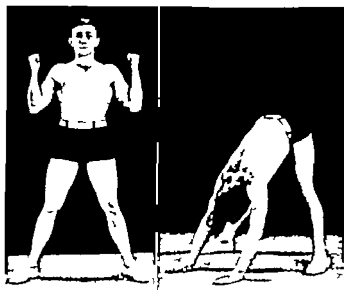


Fig 7 Fig 8

EXERCISE 5

1 Droop down on floor as in Fig 11
2 Roll head to one side leaving it awhile then to the other side. Repeat two or three times.
3 Bend an elbow hand drooping at wrist Let arm drop (It then lies loose) Forget it Repeat with other arm (Fig 12)
4 Turn one foot inward then outward (whole leg loose) Repeat other foot
5 Smile! Relax face muscles Close eyelids lightly think of nothing Remain for 30 seconds
6 Turn over to all fours stand up straight Take three quiet breaths.

When bending an elbow if you tense the muscles for stretching it you work against yourself Use the muscles you need and no others Your movements will then have power and grace

EFFECTS

The bending forward stretches the muscles at the back of the thigh

The squeezing of the contents of the abdomen aids digestion and excretion the latter is *most* important The waist muscles are also improved and the general circulation of blood through the internal organs is stimulated

EXERCISE 9

Start as in Fig 17

1 Stretch left leg backward (Fig 18)

2 Change position of legs (bend left and stretch right leg Back knee must be straight)

Repeat six times and finish in standing position

EFFECTS

This exercise develops the tissues of the legs and makes the knee and hip joints supple

The alternate extension and contraction of the abdominal muscles has a stimulating influence on the digestive and excretory organs

It also assists the circulating of blood through the liver



Fig 17

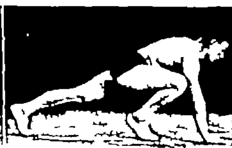


Fig 18.

EXERCISE 10

Start as in Fig 19

1 Lift the body (keeping the chin in) and simultaneously raise legs (Fig 20)

2 Return to starting position

Repeat six times

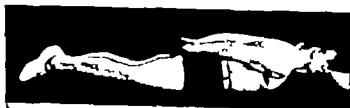
Breathe freely throughout.

EFFECTS

This is a strong exercise for the muscles of the back.

It counteracts round shoulders and flat chest

Posture is improved



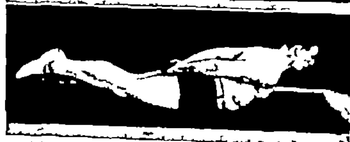


Fig. 19 (above) Fig 20 (below)

EXERCISE 7

Start as in Fig 13.

Raise heel and bend right knee and bend trunk to left, slackening slightly and press further over four times (Fig 14)

After making four presses to left change position, bending left knee and make four presses to right. Repeat six times and finish in standing position. NOTE. Always bend away from raised arm.

EFFECTS

This is a strong exercise for the muscles at the sides of the body

When bending over the ribs of the upper side spread apart and the chest is widened, allowing freedom for the lungs to work. Being alternately compressed and stretched the internal organs are affected in a pump-like manner and their circulation stimulated.

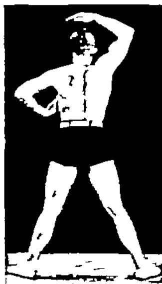


Fig. 13.



Fig 14.

EXERCISE 8.

Start as in Fig 13.

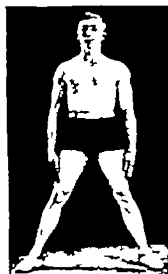


Fig 15.

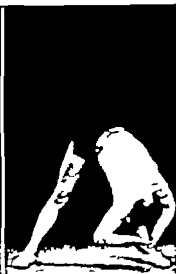


Fig 16.

1 Bend over left knee grasping ankle with both hands (Fig 16)

2 3 and 4 Slacken slightly and then press downward with body do this three times pulling with hands.

Repeat with opposite side.

Repeat six times and finish in standing position.

EFFECTS

The bending forward stretches the muscles at the back of the thigh

The squeezing of the contents of the abdomen aids digestion and excretion, the latter is *most* important The waist muscles are also improved and the general circulation of blood through the internal organs is stimulated

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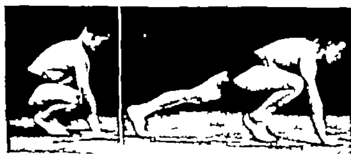


Fig 17 Fig 18.

EXERCISE 10

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2 Return to starting position

Repeat six times

Breathe freely throughout

EFFECTS

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It counteracts round shoulders and flat chest

Posture is improved

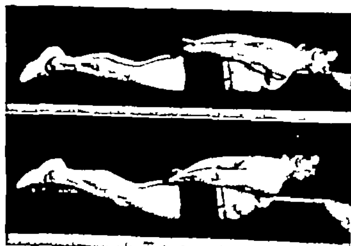


Fig 19 (above) Fig 20 (below).

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Fig 13.



Fig 14.

EXERCISE 8

Start as in Fig 15

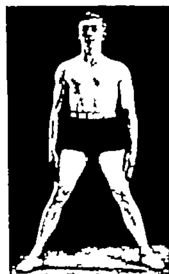


Fig 15



Fig 16.

1 Bend over left knee grasping ankle with both hands (Fig 16)

2 3 and 4 Slacken slightly and then press downward with body do this three times pulling with hands

Repeat with opposite side.

Repeat six times and finish in standing position

CHAPTER XII

TRAINING AND PERFORMANCE

THE whole purpose of physical training is to prepare for athletic performance, both physically and mentally In every sport each athlete should train according to the need of the maximum output demanded by his particular pursuit Training includes conditioning also, for this prepares the athlete for the capacity which his job may demand *and* is also a great factor in the prevention of injury It has been found that the incidence of injury is definitely related to the years of training and experience of the athlete and the athletic trainer A young athlete, at the start of his athletic career is far more likely to court injury simply because of the inability of his muscles and co-ordinated nervous system to avoid *in time* what may be the forerunner of injury This may be because he has not yet been taught, or learned for himself how to think far enough in advance. The careful training and conditioning of every athlete is really team work, and knowledge of how injuries are caused and how avoided is the duty of the trainer Many trainers are first-class men with wide experience and moreover have at their command a physician, a qualified physiotherapist and other specialists to whom they may turn for advice But the warden of a youths hostel or boys club, or even a school teacher will have no such assistance They are really the responsible people and it should be their duty to gain all the experience necessary for the benefit of the charges in their hands. All athletes may not be members of Cup-winning teams, or world beaters in track events, but athletes are athletes whatever company they keep

The schoolboy at a prep school who successfully gathers a small cup one year may be the athletic sensation in later years, providing his interest is held and his training attended to with seriousness Whatever any athlete does is serious to him no matter how elementary the class or event. Careful supervision on the part of schoolmaster warden or youth leader will certainly give to the young athlete, whether runner cricketer, footballer or what have you, an incentive and impetus to his

EXERCISE 11

Start as in Fig 21

1 Bend knee and grasp it with both hands then pull thigh against abdomen three or four times (Fig 22)

2 Return to starting position

3 Repeat with other leg

Repeat left and right six times finish lying relaxed take three deep breaths





Fig 21 (above) Fig 22 (below)

EFFECTS

This exercise stretches the muscles at the knee and hip joints and makes these joints supple.

It also produces a strong *compression on* the abdominal organs and aids digestion and excretion

The general circulation of blood is improved

WALKING

Walking is merely falling forward Lean forward from ankles till you begin to fall. Place one foot under your weight. With back foot push with toes stretching the ankle well bring leg forward to take weight, swinging opposite arm to aid balance The head keeps level (not rocking from side to side or bumping at each step) Walk evenly and smoothly (Fig 23)



Fig 23

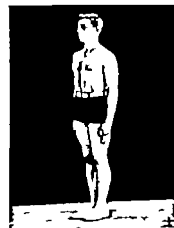


Fig 24

STANDING

Standing straight up bones should balance one on another shins thighs hips spine and head resting on parted feet as little muscle work as possible Ankle hip and top neck joint in one upright line nothing tense whole front of body free for breathing (Fig 24)





Alternate splitting an exercise for strengthening legs and hips. Useful to sprinters and high jumpers (Demonstrated by Ron Chifney former instructor to British Amateur Weight Lifters Association)

Abdominal raise. Strengthens abdominal muscles and tones up internal organs — specially beneficial to middle and long distance runners (Ron Chifney)

work which may, one never knows, make out of the callow rabbit an athlete of consequence But even if this is not so, even if the callow rabbit remains, nothing is lost, for the tryer is still there. The proper training of the young athlete will develop, as well as his muscles, his character, and in the final analysis this is perhaps the best development of all

However the evolution of all athletics and games to their present state, where many of them are highly organized commercial events, shows a greater need than ever before for adequate coaching and preventative advice. Recent advances in training have shown that it should be a gradual building up process for physical effort and not a breaking down, so that good efficient training will prevent injuries and co-ordinate mind and body to the capacity necessary for the work they are to do

Unhappily for the trainer, injured athletes are not good patients They seem to have a complete disregard for pain and their one and only desire is to recover sufficiently to be able to play games or take part in events. I know in one sport, ice hockey I have the most tremendous difficulty in persuading a player with broken ribs or wrist to rest. Only recently in a bicycle race, a rider came a cropper and fractured his collar bone, but he stoutly refused to withdraw from the race.

These things are not really heroic and I personally consider it bad management on the part of team trainers and managers where they occur But most athletes, professionally engaged are in the sport for the money they obtain from it, and as the years they have are few and they have no wish to allow the public to forget them stolidly refuse to rest. I would urge upon all athletes to consider that in any disability there is always the probability of an early recurrence if proper treat ment and rest is avoided It might be disastrous enough to force the athlete to retire prematurely and thus cause the very thing he wishes to avoid I know that trainers often meet bitter resistance from players but I do think that careful though firm handling is very necessary in these cases

Any individual in a sedentary occupation will need very little physical exercise for his muscular development and it will take very little to keep him fit By this I mean that he will have a general sense of well being that will permit him to enjoy health of mind and body Athletes who spend an entire season playing a strenuous game or partaking in heavy physical

and sports no attempt is made usually to study correct posture of the body No performance can be really good unless body balance co-ordinates with physical fitness The study of the general musculature and the correct use of muscles will prevent misuse of energy and obtain a maximum output of effort I recommend that in the training of athletes a model skeleton be utilized which should be used to demonstrate correct posture by positioning and give the athlete an idea of the nature and working of the joints Many body regions lose balance' early in life and a knowledge of body mechanics and muscular tone will help the athlete to understand the strains and aches which occur in different parts of the body Muscular tone is responsible for holding the body in normal position as well as counteracting the pull of gravity

If a car is laid up for any time it will rust and the engine will not start when we want it to The body is very much like this engine and so if we want it to be ready to start just when we decide, we must maintain it perfectly for the rule of body *use* is the rule of *maintenance* One depends on the other The body will maintain what it uses and loses what is neglected Maintenance demands effort and repeated effort will result in accomplishment.

It is important for the athlete to remember that every part of his body must be used for though many regions are in daily use others are not and are really excess baggage and only a little effort is required to move them at all I know many athletes who only move their arms and hands and fingers when using a knife and fork. In the normal way they ignore these parts and yet their performance would be increased if some maintenance and exercise were done on these as well as the rest of the body in which they seem to have so much pride Intelligent daily exercise is not a matter of choice—it is a necessity

Of the two things most vital to any athlete, one is the game or pastime itself and the other is the preparation for it. Many athletes use the game or pastime itself for the purpose of getting fit This is wrong for if he does so over a long period his play will certainly deteriorate and his rhythm will become irregular The proper demands of the sport must be understood and realized and this is important not only to the professional player of games but to the week-end sportsman also There has been during the last few years a routine to adopt games that

exercise must, however, attain the highest pitch of physical fitness In order to do this a most rigid form of routine training must be adopted and this should be enforced by the trainer The main features of good physical training for any branch of athletics football, running, rowing and so on, are—gradual muscular exercises a good and well regulated diet, plenty of sleep and the minimum of stimulants There is no need for drugs or so-called pep pills By graduated muscular exercises the muscles are developed to a stage of actual energy production and the heart muscle is developed in the same proportion, while at the same time the central nervous system is brought into control over the whole machine.

Normally a muscular individual has a muscular heart from which a great deal of hard work may be expected Every athlete should have as a first step a thorough physical examination and make known to the doctor his complete history It must be certain that there is no pathological lesion of any system which might interfere with physical exertion Perhaps a word or two about athlete's heart might be made. I consider this a rather unfortunate term because there is no reason to suppose that such a thing can exist. The heart of the athlete is increased in size and musculature in direct proportion to the size of his muscles Whatever the size of one's muscles the ability to perform muscular work is determined by the output of the heart The normal heart is no more likely to be injured by strenuous exercise than any other organ or muscle in the body and certainly taking part in athletics however strenuous, will not produce an athletic heart for the simple reason that such a thing does not and cannot exist Of course one cannot avoid altogether the possibility that an organic heart disease may be present in any person, and anyone having such a disease would be foolish to take part in any prolonged or strenuous exercise.

Physical training leads to efficiency in the performance of physical work. This is shown by a decrease in oxygen consumption and a smaller output of carbon dioxide A trained athlete can undergo severe exercise without accumulating fatigue products in the blood and tissues Development of all the necessary systems of the body will extend the limit of the potential energy which a man or woman may develop

I would like to mention one thing which somehow seems to be forgotten in general training and this is that in all physical exercise and particularly in training and preparation for games





Lateral raise lying De velops chest muscles Very beneficial for all athletes especially for discus throwers (Ron Chifney)



Abdominal exercises A simple exercise for all athletes with special benefit for hurdlers (Ron Chifney)

do not require training, such as golf and then expect that these games will bring about the necessary standard and exercise for fitness Of course, they cannot and do not. How can a game of golf provide the necessary exercise and training for say, football or ice hockey? All it can provide is relaxation. The most worth while games in my opinion are those that require intensive and regular training This is where the useful and healthful exercise is and any person who cannot properly *prepare himself for a worth while sport should never play it, for* he is a burden to his colleagues

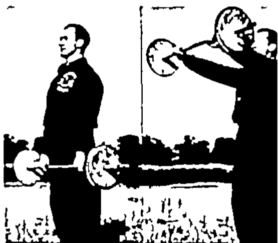
There is no doubt that continual training and development for a sport will do much to take away the element of danger and injury in that sport, for an alert fully trained athlete, by his lively use of mind and body can often prevent an injury, while a sluggish dull thinker and badly trained athlete will often be the cause of one.

Muscles are only adequate when they can handle the body weight effectively, so that a programme of muscular development should be laid down which includes exercises for every muscle group and body region. It must be remembered that in all athletic pastimes and sports, movements are known as coarse ones This is because large groups of muscles are involved The athlete is concerned in running jumping hitting, kicking and so on and not turning a key in a lock. Whenever possible the best place to train is a gymnasium Most large clubs possess an adequate one, and these facilities should be extended to smaller clubs If this is not possible, some hall may provide facilities, and there are institutions such as the Y M C.A. where facilities may be provided for a small fee Drill halls too up and down the country can be used in this manner I would like to see the establishment of training groups in specially equipped places Equipment is not expensive and if necessary many objects can be adapted to the required needs It is not fair to restrict athletic training of youngsters and others who cannot afford the membership of big clubs to a run round the back streets or round a public park *on one or two evenings* a week. *I am sure that the facilities* are there if they are sought. The reason why Continental and American athletes are so fit and well trained is because of this very provision and because of the technique applied to training which is perfected by hard work and skilful coaching and a high degree of motivation and interest



The Dyson twist Develops hips and trunk This exercise was devised by Geoffrey Dyson coach to the A.A.A. (Demonstrated by Al Murray Hon National Coach to the British Amateur Weight Lifters Association)

Forwards and upwards raise Strengthens shoulder and upper back muscles (Al Murray)





Trunk exercise for lower back and hip muscles (Al Murray)

Let us now turn to the various body regions where training is vital It is a common fact that weakness does exist in arm, hand and shoulder muscles in most athletes Past instruction in sports has not provided enough use of the muscles to bring about development of these muscle groups Very few boxers can punch their weight and among the heavier grades it is very often deplorable to watch big men flay the air with tepid airy swings Too much time is spent on road running when it should be spent in the gymnasium developing the muscles which the boxer uses in his work. Most sports find the necessity for developing shoulder and arm muscles yet the sport itself in which the athlete engages very seldom does this Trainers should recognize this and provide a programme of heavy muscular exercises Weightlifting is possibly the finest way in which to develop these muscles and there is no hardship about this method of training Wall bars should be provided and used daily Ten or fifteen minutes each day spent in the exercise known as chinning' where the chin is raised up to a bar by the arms will develop the biceps and shoulders and teach control of the abdomen Push ups from a wood floor is another valuable exercise and parallel bar work will develop muscles and co-ordinate rhythm of movement as well They can be varied by rope climbing hand stands, and hand springs on a mat. Hand to hand walking moving one s weight, will teach the athlete to handle his body effectively and in a combination of all the movements described, he will learn to control his body posture and increase his mental co-ordination.

Proper training for athletics should include analysing muscle actions in joints, and every trainer should be able to analyse movements and pass them on to the athlete. There should be an understanding of the body levers and power relationships because by a careful study of muscle movement it is possible to correct any weakness in postural activity and so prevent poor performance. Part of all athletic training should consist of theory of movement and I have already mentioned the provision of an articulated skeleton. Clubs should also provide an atlas showing muscular attachments and a training session could be provided in which both theory and practice is taught The athlete should not only know how to run but which muscles are taking part in the action. Each athlete will take interest in his own speciality and develop these regions effectively The rule is too often to get the athlete out in the



Squat Jumping A splendid exercise for strengthening legs eminently suitable for all athletes (Ron Chifney)







Alternate one hand swing Develops shoulder and back. Specially designed for hammer throwers (Ron Chifney)

field, race him round and round until exhausted, then give him a shower and a slap and tickle which passes for massage. This is not training and the time is ripe enough, in fact long past when athletic training should be treated as a science and given all the benefit of scientific study by highly skilled and experienced persons

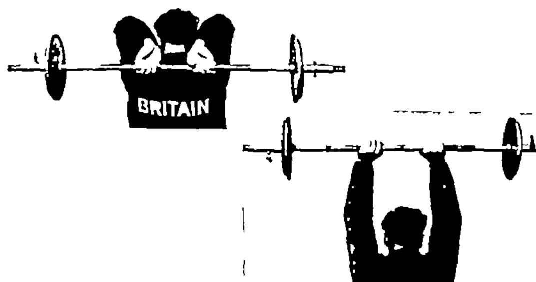
Once the fundamentals have been laid down and implanted in the athlete's mind he will find by trial and error the programme most suited to his individual needs It is a little difficult to lay down hard and fast rules for everybody, but general training should be approached just as would training for a profession But certain fundamental rules should apply to all training, and the basis must have a definite purpose.

In developing the arms and shoulders it might be remembered that this should be common to all athletes The reason is this—maintenance of strength in the shoulder group is called into play when relating these muscles to the chest. A greater flexibility of the wall of the chest is developed when allied to the shoulder muscles and co-ordination will increase the ventilation of the lungs In this way many shallow breathers will become deep breathers, thus increasing wind and endurance.

Particular attention should also be paid to the muscles of the abdomen, as these tend to weaken especially after the age of twenty five. A careful diet should be aimed at reducing any increased girth. For this reason the push up exercise already referred to is ideally suited Trunk raising is also useful For this it is best to lay on your back on a hard floor Keep the knees bent and feet firmly planted on the floor Place the hands on the abdomen and then try and lift the head and shoulders as high as possible If done daily about twenty times they will be found to be very useful toning up exercises for the abdomen

Leg muscles are very important and a good general exercise is known as quadricep drill Here the athlete is flat on his back on the floor A variety of sandbags of increasing weight are placed over each ankle and kept in position with tapes sewed into the sides of the sandbags Weight should commence at about seven pounds and increase to fourteen pounds The legs are raised alternately keeping the knees fully *extended* until the heel is raised about twelve inches from the floor This exercise should be done about twelve to twenty times with each leg and should not be hurried Slow deep breathing should accompany the exercise. Following this, both legs can be raised for about

and the athlete If you learn to handle your body weight, and build up the fundamental development necessary to the proper performance of the game or pastime which you enjoy, it can make you a better athlete. You will certainly be a fitter one and a happier one



Triceps stretch Strengthens arm action and suitable for cricketers javelin throwers etc. (Al Murray)

twelve times and after a short rest the alternate lift can be done once more.

The medicine ball should not be left out of any group exercises and the stationary bicycle is a good means of exercising all the leg groups of muscles from the ankle to the hip

It is usual to neglect exercises for the feet, yet these are essential for the life of the athlete It is essential to walk or run with the feet rather than 'over' them, so to speak, and it is just as important to bring them into any general programme of fitness as any other body region. Tiptoe walking and walking on the outside borders is an excellent strengthener to the foot muscles and will produce increased tone Rotation of the ankle, upwards and downwards and inwards and outwards, will help flexibility Attempts to pick up a piece of string or a pencil with the toes will all assist in effecting control of the foot muscles. All exercises should be done in bare feet.

Before I bring this chapter to a close I would like to say a word about sprinting I know this problem is an acute one in many clubs Yet I cannot understand why so many football trainers, for instance, insist on hard and fast lapping two or three times a week. No footballer finds it necessary to run more than perhaps thirty yards at speed, and I see no reason why football training should consist of so much lapping This can only sap the energy and has little practical value, except to a runner for it is his work and the only way he can assess his performance But for other athletes it is unnecessary For these, practice starts, and sprints of thirty to fifty yards are enough, but as a winding up for the day perhaps a lap or two in plimsols will not do any harm, so long as an easy limbering up pace is maintained Every athlete will derive more actual benefit from the physical exercises described which will develop him fundamentally than in long weeks or months of sprinting

It is the job of the trainer to get his men fit and keep them fit This chapter has been written with this in view as the sole aim. My talks with trainers of all kinds have convinced me that no two are agreed upon fundamental training I would like to urge them to forget all past prescriptions and give scientific fundamentals a chance. I know they can pay dividends A definite curriculum of physical training should be drawn up for every athlete weekly with special reference to the particular needs of the individual athlete.

All pastimes demand a special type of training suited to it

firstly, by the provision of sound scientific training and conditioning, which I have already dealt with in a previous chapter and which I will go on stressing, and secondly, by ensuring that the athlete, during training and participation, has an adequate diet with a sufficiency of carbohydrate reserves, which can be fortified with vitamins and salt intake. Training should be gradual and the athlete must not be in a hurry to reach his peak He should build up for it by graduated exercises. Training should always be directed to the end in view It is important to preserve and increase wind and endurance and no better method can be found than that already outlined

There should not be any recourse to artificial stimulants No drug should ever be used on an athlete to push him beyond the limit of his own endurance and no responsible trainer should contemplate it.

Research work done on many famous athletes, especially long distance runners, shows that by good training and diet and an adequate salt intake, these men adapted themselves to a high physical pitch together with wind and stamina. At the close of their work they were comparatively fresh and the work was actually done with ease.

These athletes all showed that they possessed a high oxygen intake and a low acidity and developed extraordinary efficiency in both heart and circulation.

When an athlete is tired he goes stale In addition to his fatigue he is irritable, he has little appetite and cannot sleep and more often than not develops an acute state of sensitivity He easily gets the jitters When this happens it is advisable for the trainer to give him a complete break from training and playing His fatigue is physical and mental and can be compared to a nervous break-down The only treatment is a rest absolute and complete, from all participation. But if the fundamental rules outlined are followed with common sense and efficiency I am sure that this state would never happen

CHAPTER XIII

THE PROBLEM OF FATIGUE IN EXERCISE

No discussion of physical exercise, whether in training or actual sport participation, would be complete without an attempt to analyse fatigue. Any severe exercise will result in fatigue of the muscles and with them the heart and nervous system. This will produce in the body a lack of co-ordination so that there is reduced ventilation and transport of oxygen and improper removal of waste products It may be that fatigue will produce only lack of response or a slowing down in the muscles alone, but can also cause faintness, giddiness and often sickness.

There is little doubt that exhaustion of the more serious kind is more often found in the young athlete than in the experienced one. This is found to be solely due to lack of proper training and preparation and inadequate feeding There are, of course, unfortunate cases in the boxing world where youngsters have been worked to death fighting several times in a week and in a little while are punch-drunk from sheer nervous and physical exhaustion. Happily, this is rarer nowadays than it was twenty years ago Very little severe exhaustion has been noted in the experienced athlete. Exhaustion of some kind is common to all games and sports and in cross-country running marathons and after boat races there has been perhaps more notable examples Very often examination has shown a marked acidosis in the blood which has led to the feeding of glucose during games and often in training

I feel sure that controlled training, fundamentally, by a specialized team would reduce to the barest minimum any state of fatigue in athletes. In particular the young athlete needs careful handling and in my opinion it would be a sorry state of affairs if because of a good heart and lots of enthusiasm the young athlete were to burn himself out before maturity This has happened and is going on happening and it will take very little to put to a stop one of the principal causes of physical fatigue in the athlete.

How can fatigue be prevented? In my opinion very simply

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An alert athlete is a safe athlete How injury is avoided by full match fitness, mental and physical

CHAPTER XIV

THE PREVENTION OF INJURY

If sport is to be of any benefit either to the participant or to the spectator injury must be kept to a minimum both as to severity and frequency The control of injury and the development of the athlete must go hand in hand Present-day organized sport is the result of teamwork of a highly developed character Co-operation by athlete, trainer manager and club doctor is a team matter and should be approached from this angle. An enthusiastic athlete is very often too critical regarding what he considers cautiousness or old maidishness on the part of the doctor or trainer This is unfair, because the responsibility for fitness rests just as much on these officials as on the athlete, and they are just as concerned in the athlete s or the team s success Further it is the job of the trainer to deal with the injuries and keep them as low as possible.

The bugbear of all trainers is recurrent injuries because they result in weakened and unstable joints and muscles All persons in contact with athletes are just as concerned in preventing injuries as in the cure of them when they happen. Continual examination by the trainer can ensure that injuries are kept to a minimum. A weak joint or muscle can always be strengthened by effective strapping and I have devoted one chapter to this subject at a later stage in this book. Treatment of cuts, bruises and a general going-over or light massage, should be routine. Never let anything get worse by carelessness Ensure adequate rest either between events or, say, at half time in a football game.

In many games considerable protection is given to players by wearing harness This is of course, impracticable in games such as football or cricket but I see no reason why some light preventative strapping for the joints cannot be done I have devised some very effective strappings from light elastic webbing and surgical felt for knee and ankle joints, and they have added stability and are light and easy to wear The same has been done for many athletes who are a little weak in the lumbar muscles and who frequently strain the joints of the pelvis near the backbone. These weak regions can be afforded



A further example of mental and physical co-ordination. Note the restraint of the attacking forward.

additional support which gives the athlete more confidence. I am sure that these strappings can be improved upon and standardized if necessary

A frequent injury is a thigh strain which occurs usually at the beginning of training The athlete tries to work off excessive weight gained in the off season and subjects himself or is subjected to, hard and fast sprinting, very often from crouched positions The reason is that the thigh muscles are unaccustomed to such a severe strain so early in training and they fail to respond to a quick starting action, often causing a serious rupture. This injury is easily prevented by starting training with slow laps and gradual toning up exercises until the muscles are in tone and can take the strain of severe contractions

Blisters are often caused by ill fitting boots or track shoes. All footwear should be snug and properly measured before wearing

It is useful to keep records of all injuries, and every athlete should have a case history sheet on which the trainer should record all details of injury, period of absence from athletics or play, treatment carried out and recovery notes If an athlete is injured towards the close of the season do not allow him to wander off without effecting a cure of the condition It is more than likely that many an athlete will take only too cursory a view of the injury and will not be fit when the new season starts.

The greatest prevention of injury is adequate supervision of the athlete by the trainer It is his responsibility and he should be firm in treating it. Upon the trainer's observation skill and tact many an athlete owes his well being and certainly the success of any team sport will depend on this in a busy hard season

Emperor thereupon ordered that all veterans should form themselves into corps and when in pain should rub one another

The Greeks had a regular system of gymnastics combining baths, massage and exposure to air and sunlight Eventually a school of gymnast physicians arose who used these means as therapeutic agents for the treatment of all kinds of diseases Gymnastics in the treatment of injury were used by one of these physicians about 428 B C. In nearly every large city in ancient Greece gymnasia were set up and they became important centres where exercises were carried out. The ruins of the buildings, which are of great architectural beauty, are still to be seen

A physician called Hippocrates, known as the Father of Medicine, wrote these words in 380 B C. and they may well be followed at the present day He said 'A person must be experienced in the art of rubbing for things that have the same name have not the same effect For rubbing can bind a joint that is too loose and loosen a joint that is too tight. So we see that rubbing can bind and loosen, can make flesh and cause waste. Hard rubbing will bind, and soft rubbing will loosen but while it must be remembered that moderate rubbing will cause parts to grow much rubbing will cause waste.

It must also be remembered that rubbing upwards in the case of limbs has a more beneficial effect than rubbing downwards

How does physical therapy work in the case of injury? We have already seen that the body is a storehouse and transformer of energy Chemical energy is stored up in food which is split into small components and keeps the body functioning Some of these chemical processes create physical energy, such as heat, either as a by product, or as an essential object Physical energy can also be conveyed to the body from outside and thus stimulates the body processes Any form of physical energy applied to the tissues exerts in turn chemical action on the part of the cells, which influences or brings about certain conditions and thus creates therapeutic effects

Perhaps we can discuss now briefly the principal physical agents and their effects

At the very simplest we have hot water, hot air, and natural sunlight. Then we have radiant heat lamps infra red and long and short wave diathermy All these things produce heat In

CHAPTER XV

THE TREATMENT OF ATHLETIC INJURIES BY PHYSICAL MEANS

THE value of the treatment by physical means of injury in athletes is now well established and the story of the development of these means goes back through many centuries In a primitive way they are very old indeed, as they go back to the sunlight, baths and massage of the ancient Greeks and Romans Some authorities attribute the word massage to the Greek word massein which means to knead, while others think it may have come from an Arabic word Mass or Mas h which means to press softly Many years before the Christian era the Chinese had a system of gymnastics and massage which is recorded in ancient writings There is also mention in the sacred book of the Hindus, and it is certain that massage and heat was practised by the Persians Egyptians and Japanese. In fact these physical methods of treating injury were in an advanced stage among Greeks and Egyptians around 1000 B C.

Homer mentions in his writings the anointing and rubbing of war heroes in order to refresh and restore them An amusing story concerns the Emperor Claudius, who one day crossed the square of the City on his way to the Forum when he came upon a veteran of the recent wars rubbing himself against a stone pillar On inquiring what was the matter the Emperor was informed that the veteran was aching in every limb and was trying to obtain some ease by rubbing his body up and down on the stone pillar Alas he moaned I have to do this for myself because I have no slave to rub me. The Emperor took pity upon the poor man and ordered that the veteran be given two slaves and a house so that for the remainder of his days he would have a roof over his head and be free from pain

The following day when the Emperor crossed the City Square as usual he beheld the unusual sight of thousands of men all standing against pillars and rubbing themselves up and down On inquiring from a centurion what was the trouble, he was informed that they were all veterans of the recent wars, they were all in great pain and had no slaves to rub them The



A group of Chelsea players receive physiotherapy treatment from their trainer Mr Norman Smith

the next group we have again the sunlight, heated metals, and ultra violet light, produced either by carbon arcs or mercury vapour lamps These produce pigmentation in the skin and cause a tanning effect They also produce a substance called Ergosterol[1] which assists in the manufacture of vitamins In the next group we have the galvanic current which gives us some small heating but is used for reducing swelling and stimulating the cells and muscles, and the faradic current which is a powerful stimulator of large groups of muscle, and frequently used in effecting strong contractions Finally we use massage itself which is an extremely useful agent.

One important thing is to remember that physical therapy must not be practised apart from general medicine, but should be allied to it on the advice of the club doctor Physical therapy is in fact a part of medical practice and should be used under the immediate supervision of a physician who should always be advised just what means the trainer contemplates using in a particular case. It is also important to obtain firstly a clear diagnosis On the other hand no treatment of injury should exclude physical means altogether There is ample need and opportunity for the systematic use of physical means in the treatment of athletic injuries and the trainer, if he is to do his job thoroughly, should have a first-class knowledge of what these measures involve He should know that just as a method will do good it will also cause harm if not applied correctly or efficiently The object of physical therapy is to bring about certain responses and the trainer should be able to choose from his available apparatus according to circumstances and the needs of the particular injury he is to treat. He should have no difficulty in making up his mind once he has had sufficient experience and theoretical grounding and acquired clinical competence under trained medical guidance.

Physical treatment must always be properly indicated and not applied if other and more important treatment is advisable. The treatment selected must be the best suited for the condition and applied with skill intelligence and diligence.

All treatment must be commenced at the earliest time following injury and it should cease when the patient is able to do for himself what the treatment is designed to help him perform. Never be persuaded by a lazy patient to go on with

[1] A substance of animal or vegetable origin having properties like the fats. On irradiation it forms vitamin D_2. Necessary for the prevention of Rickets.



A swollen ankle is investigated by the Chelsea trainer

treatment once you consider that he is in a position to help himself

Nearly all injuries show immediately an escape of blood and lymph fluid from the torn vessels and capillaries. There may be swelling and tearing of ligaments, rupture of muscles and tendons, and injury to bone or cartilage. First indications are treatment for shock, stopping any bleeding, prevention of any infection, and if fractures occur, splinting and uniting broken surfaces For years the routine treatment of injury was immobilization to provide undisturbed healing This ignored the fact that for the repair of injury efficient blood supply is necessary The rest promoted, in fact, the formation of adhesions Present-day treatment provides rest only for as long as it requires to knit together broken surfaces or torn ligaments Too much rest leads to muscle waste. Never neglect any soft tissue injury as this leads to delayed recovery

The object of physical treatment will vary very much in different cases according to the type of injury and the individual *Treatment should be adapted to the individual case*, and apparatus should be provided that will give every possible treatment that any condition will call for

Generally speaking all treatment can be divided into two main groups, acute and chronic In acute cases the objects are—relief of pain and relaxation of muscle spasm promotion of absorption of escaped fluid prevention of adhesions and assistance in the processes of repair and the restoration of function. In chronic cases the objects are—removal of the causes of inflammation, softening of adhesions or scar tissue if formed improvement of nutrition in muscles and mobility in joints

In a general scheme of treatment accurate diagnosis is vital. You must know what you are treating Decide whether the injury needs immobilization and watch for cuts, bruises, abrasions or lacerations Wash carefully with a good antiseptic and if the injury is round a joint and swelling is present, use ice-cold compresses, then apply several layers of lint soaked in *lead and opium solution, or paint the area with a solution* consisting of equal parts of tincture of iodine and tincture of arnica. Then strap effectively with elastic plaster bandage and rest the part If the circulation is impeded you can use a large wattage radiant heat lamp but do not use any hard rubbing in any recent injury When the acute stage has passed heat measures can be introduced for improving circulation and for



A swollen ankle is investigated by the Chelsea trainer

the relief of pain and to hasten absorption of fluid. Short wave is the treatment of choice but infra red rays may be used Galvanism can also be used, and if massage is employed long stroking movements are the best. The part may be strapped for as long as it is considered necessary or effective.

Following chapters will discuss more thoroughly the various physical measures employed and indicated in the treatment of injuries

CHAPTER XVI

PHYSICAL METHODS IN THE TREATMENT OF INJURY

OF all forms of physical treatment employed undoubtedly massage is the simplest and most generally useful In its application the hands of the masseur transmit a mechanical action to the body of the patient. Husky rubbing bears no relation to scientific massage and the effectiveness of the treatment does not depend on the amount of physical effort expended The masseur must learn by touch to adapt his movements to the conditions he is treating and to the contour of the limb or trunk. He should also have a good knowledge of the anatomy of the part and an understanding of the injury for which the massage is being used. Massage is not an art which can be taught by words, but by continual practice under competent guidance.

Three main varieties of movements may be said to be employed sometimes singly and sometimes in combination They are *stroking compression* and *percussion.*

Stroking is perhaps a fundamental form of massage and is almost instinctive in the human being When a child falls and bruises itself the mother gently strokes the child s bruises with the palm of her hand to relieve pain and reassure the child Every massage treatment as a rule, starts with stroking An even pressure is exerted along a definite path, and pressure is always exerted towards the centre from the outside This is to stimulate the blood and lymph circulation On small surfaces it can be done with the thumb or the tips of the fingers and on large surfaces with the palm of the hand or with the inner side of the hand

Stroking has a sedative effect and should be done with long slow movements The masseur s hands should be relaxed and ready to adapt themselves to the contour of the treated part They should always be in contact with the skin, returning to the starting point before changing direction to another part Stroking can be deeper if it is necessary to unload the lymph channels of waste Pressure should not be heavy and the

muscles of the patient should be relaxed Rhythm of the movement should be uniform and not too quick.

Compression movements are effective for accomplishing the most frequent object of massage in athletes, which is the toning up of muscles and of breaking down adhesions The principal difference between stroking and compression is that in the former the hands or fingers of the masseur slide evenly over the skin, while in compression the skin of the patient is carried along in order to act on the deeper tissues. A variety of pressures may be used in compression movements and these may be considered under the titles of *kneading* and *friction*.

Kneading is a mixture of grasping and pinching' with varying degrees of pressure. The masseur picks up the skin and deeper tissue with a small amount of force between the thumb and fingers but without pinching enough to cause pain The skin should move with the hand of the masseur and the deeper structures are massaged under pressure from the fingers. It is best done by two hands opposed to one another and the thumbs and fingers can be used to reach individual muscles if necessary The main effect of kneading muscle or soft tissue is to aid in stretching adhesions and removing waste products from the muscle.

Friction is a circular form of kneading with pressure against a part of the tissue which cannot be grasped It can be done by tips of the thumbs working in opposite directions or by the tips of the fingers or by one hand open or clenched Friction by the tips of the fingers is used when treating joints while over fleshy parts such as the thigh or lumbar muscles of the back, the entire hand may be used Friction is especially useful in the manipulation of smaller parts such as the hand or foot, and the chief effect is to loosen adhesions of tendons and to free scar tissue. It should always be preceded and followed by stroking movements and carried out in the same direction.

Percussion is the most stimulating form of massage, and one which can do most harm if movements are too clumsy It exerts a very stimulating effect on muscles and superficial nerves and on the skin and blood vessels. Percussion includes slapping clapping tapping and beating according to the position of the hands and fingers. Slapping should be done with the inside surfaces of the fingers which should rebound from the skin after each movement. The effect is to stimulate the surface capillaries and nerve endings Hacking is done with the little finger side

of the hand and consists of quick chopping motions from the wrist joint If properly applied with relaxed wrists, this movement will release muscle spasm. Tapping and beating are not very often used, but if the need arises to stimulate heavy muscles it can be done with the lightly clenched fist

The main effects of massage are a general sensation of warmth and stimulation of the skin. Dead cells are removed from the surface. Circulation is improved and increased nourishment passes while waste products are removed

The chief objects of treatment by massage are undoubtedly muscles and the lymphatics. Massage applied to a resting muscle increases its power for work and prevents accumulation of fatigue products Massage applied to a boxer between rounds for example, would have a marked effect on his recovery and would enable his muscles to do more work when brought into play It restores tone and strength which has been lost in the exertion demanded in a contest or athletic event. Further, firm pressure by stroking over an aching nerve will lessen the ache A tired nervy athlete will find sleep easier to come by after a general body massage.

It is often useful to warm the part by radiant heat before massage as it helps to soften the skin and relaxes the patient. There are many good lubricants available, and some masseurs prefer oil while others use talcum powder I would not advise heavy oils, nor irritant ones (I myself have a preference for a light cream which can be purchased in any chemists and which contains Adrenalin, as I find that massage is able to be deeper without causing pain) or the mixture of glycerine and surgical spirit already mentioned or Arachis oil The skin should be carefully wiped of any residue afterwards and an astringent such as Witch Hazel applied which acts as a good tonic effect

The Galvanic Current This is perhaps the oldest known form of electricity current flow and was discovered by an Italian physicist, Galvani in 1789 It came into general use for therapeutics towards the latter end of the 1800s. It is a constant or direct flow of current in one direction. The main effect on the body is a chemical one, because it causes a migration of molecules from one place to another and while it is happening a small amount of warmth is felt

Galvanism can be applied direct to the body for stimulation to the skin and muscles it increases circulation and nutrition in the path of the current It is very useful in the relief of pain and

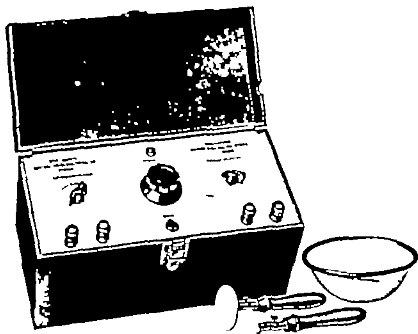
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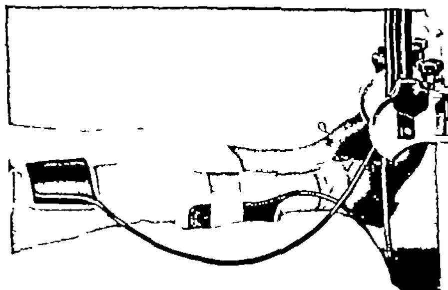
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A modern unit giving a combination of low frequency currents used in medical electricity



Short wave treatment applied to the leg

the improvement of circulation speeds up the dispatch of the products of inflammation. Galvanism is of the utmost value in a number of conditions met with in athletic injuries such as bruises, sprains and strains, etc

The proper way to apply galvanism is by using metal electrodes, that is, pieces of specially treated metal carefully cut for the size of the condition to be treated and these are wrapped around by moist cloths which have been dipped into a warm saline solution The cloths must be carefully wrung out and be free from wrinkles, nor must they be too wet or too dry If this happens the treatment will be painful and burns may be caused. When the electrodes are completely covered in the cloths (this includes the terminals) they are strapped with a rubber bandage to the part to be treated On the average the normal skin will tolerate about ½ to 1 milliampere of galvanic current for every square inch of electrode surface, so that the size of the electrode will furnish the best indication of the strength needed. If small electrodes are used, less current is needed because the current density is greater The best guide of toleration is, of course the patient, no matter what the meter reads if the patient tells you he is uncomfortable turn the current down. Galvanism can be applied without reference to polarity of the electrodes unless one is using a drug for ionization purposes but as this is not very likely except by a trained physiotherapist, it need not be discussed

In all galvanic treatments the chief danger is one of burns so that great care must be taken. If in any doubt inspect the area under treatment continually It is better to switch off and remove the cloths several times than risk a galvanic burn. All sensations of undue warmth or pain should be taken into account.

The galvanic current can be interrupted to produce a nerve or muscle twitch and so stimulate the part. This is produced by a mechanical device placed in the circuit which interrupts the flow of the current at regular intervals. This form of interrupted current is very useful in stimulating weak muscles after severe injury and specially where there may have been a nerve concussion.

The Faradic Current The Faradic Current does much the same work as the interrupted galvanic current already described though the current is different. Faradism can be applied either surged that is the current reaches a peak then flows gradually

The principal effect of short wave heating is that the tissues can be heated uniformly and deeply and the uses to which the current can be put are numberless in the treatment of injuries It can be used alone or in conjunction with either galvanism or faradism or massage.

I have used this method of treatment in such varying conditions as sprains boils, and nasal catarrh In boils particularly short wave is specific and not very long ago a well known footballer was sent to my clinic with five severe boils on the buttocks. He had been out of training for several weeks and was in considerable pain He was treated with short wave, using a small glass-covered electrode on the site of the boils and a large dispersive electrode was placed on his abdomen. In five days the boils were clear and there was no scarring of tissue. This happened after all other treatment had failed, including surgery

For joint injuries of the ankle and knee the coil method is efficient and convenient For nasal sinusitis and catarrh a small glass-covered electrode is placed over the sinus and a large dispersive at the back of the neck Heating can also be done through the face from one side to the other by two small glass-covered electrodes Following the short wave heating galvanism can be used with a special nasal electrode called the Franklin Nasal Electrode The method is to wrap two small gauze strips around the ends of the electrode and insert carefully into the nostrils. The gauze should first be soaked in a solution of one per cent Zinc Sulphate which can be obtained from any chemist. A dispersive electrode wrapped in a moist cloth soaked in saline solution is strapped to the hand The nasal terminal is attached to the positive pole of the galvanic machine and the dispersive at the negative and the current can flow for about fifteen minutes at 1–2 milliamperes I have treated many hundreds of cases of nasal sinusitis and catarrh in my clinic with success and a large percentage have shown no return in many years While it is not altogether a certain cure I would recommend that it can be tried on all athletes who complain of snuffiness and who catch co'd easily or who suffer from hay fever

Infra red Rays Radiant Heat and Ultra violet Light Any object which is heated to a higher temperature than its surroundings will send out its excess of heat by radiation to the surrounding objects. The most natural form of infra red radiation is sun

down to be hardly felt, or it can be interrupted so that the current flows for a definite time, and then ceases for a short while before continuing To prevent fatigue in the muscles while administering treatment it is useful to have the current flow for a shorter time than the rest period While the current flows the muscle contracts, and in the rest period it returns to normal The faradic current is without a doubt the best way of exercising normal muscles

In the treatment of various injuries as a result of athletics, graduated muscular contraction has made rapid advances in recent years. It can be used in muscle and ligament strains and in adhesions. It is valuable in after treatment following fractures, and any wasting condition following injury or over-strain The object of the treatment is to restore tone to injured muscles and to prevent adhesions and it increases the blood supply and so stimulates the rate of repair in injured parts at the same time as it assists in the absorption of waste products.

The treatment is applied in the same way as in galvanism, with moist cloths over metal electrodes, strapped over the affected part.

Though generally speaking both galvanism and faradism are valuable for similar conditions it has been found from experience that in cases of injury where muscles are still weak galvanism is the better method When the muscles get better and show increased strength and tone, faradism can then be employed to give the final touch in restoring an injured muscle to its full strength and usefulness

High Frequency Current This is a current which oscillates at such a high rate of frequency that the oscillations are transformed into heat The most modern and up-to-date method of high frequency heating is known as short wave diathermy and this is the form of heating generally employed. Some people still use long wave diathermy oscillating at about one tenth of the rate of the short wave, but it is rapidly passing out of favour In any case the short wave current is far more beneficial and can be used with much greater ease The methods of producing heat by short wave applications are by using two round metal electrodes of varying sizes protected by glass coverings or flat rubber electrodes which are strapped on to the skin being first insulated by felt pads or by the use of a rubber coil The coil method is very useful for limbs as it can be wrapped around an arm or leg quite simply

Goggles should always be used, both by patient and operator, and dosage should be carefully timed, and skin reaction carefully noted No trainer would be advised to use this form of treatment as a general therapy, unless, (*a*) he has had instruction under a competent physician, or (*b*) he has the assistance of a qualified physiotherapist In all cases ask the club doctor whether its use is advisable, because there may be many indications against its use which only a physician can determine

Ultra violet rays are emitted either from carbon arc or mercury vapour lamps in the artificial source, and from natural sunlight They act upon the skin and produce tanning which stimulates the mechanism for the production of the substance known as Ergosterol thereby assisting in the manufacture of vitamin D It has also excellent qualities in its effect on growth and circulation and in the general metabolism of the body Mild doses are given for a 'toning up and in my clinic it is used extensively for skin conditions such as impetigo, and in healing ulcers and infected wounds I have also found it invaluable in treating athlete s foot, and very often in respiratory conditions It should be repeated though, that application of ultra violet light should be the responsibility of the doctor, and when it is ordered great care must be taken in its use

light, but owing to it not being available as and when we need it, artificial sources are manufactured There are two kinds, the non luminous infra red emitter, and the luminous or radiant heat lamp, but the principal feature of each is to emit infra red radiations In actual practice either lamp can be used with good results, for if really deep heating is necessary for any condition short wave would be preferred Infra red heating will produce relief of pain, increase of local circulation and relaxation in muscles It can be useful in the resorption of products causing inflammation as they aid the natural defence mechanism of the body Infra red is possibly the simplest form of heating body tissues apart from a hot water bottle, and every athletic trainer finds almost daily use for it.

It is used for both acute and chronic injuries, muscle strains, abscesses synovitis and teno-synovitis, and radiation is always effective before massage or before muscle stimulation by galvanic or faradic means because of the increase in the local circulation produced by the heating

The choice of either the non luminous or luminous types of lamp depends on the individual though in my experience luminous lamps are deeper in penetration and give greater heating and can be used where injuries are in the deeper tissue and where there is much inflammation. It is also desirable if you require a greater amount of perspiration If the athlete has a very sensitive skin the non luminous lamp may be preferred as some athletes do find the radiant heat source more irritating When a lamp of high power is used it is best to protect the eyes of the patient with goggles. The size of the lamp depends on the size of the area to be treated for ankles, knees wrists etc. a small lamp will suffice, but for the trunk thighs and buttocks, a larger lamp would be the more useful

Ultra-violet Radiation. Perhaps the first thing to be said about the use of ultra violet light is that the greatest possible care should be taken and it is not advisable to give it in a haphazard fashion without the advice of the club doctor Of all forms of physical treatment, perhaps the one causing the greatest inconvenience and danger to the patient in the shortest time is ultra violet light. If used indiscriminately and without any knowledge of its harmful properties it is a most dangerous instrument. I have known of too many trainers who becoming possessed of a lamp have irradiated every person within reach on the ground that a bit of sun is just what you need

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CHAPTER XVII

GENERAL INJURIES AND THEIR TREATMENT

We may now discuss the general type of injuries which most athletic trainers are called upon to deal with and in this chapter I propose to give as much detail as necessary, both as to pathology of the condition and the treatment considered most suitable.

Possibly the most frequent condition in athletics is the simple bruise, or contusion which appears as a swollen discolouration of the skin It is usually tender to the touch and if in the region of a joint there is limitation of movement Contusions may be superficial just the skin may be bruised or they may be deep and affect the muscles or bone. Superficial bruises are trivial as a rule and do not require much treatment. Swelling occurs as a result of bleeding from the capillaries However following the rule that anything simple may lead to something severe if not treated well and quickly it is advisable to give cold compresses or paint with a solution of fifty per cent each of tincture of arnica and tincture of iodine, or a lotion consisting of lead and opium

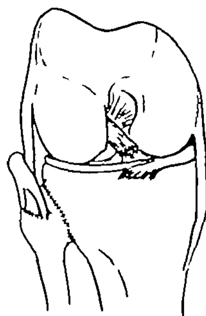
In a contusion of a joint there may be some bruising of the capsule and some bleeding from capillaries within the capsule wall *The joints most affected are the knee and elbow* but sometimes a severe bruising takes place at the joint at the junction of the shoulder and collar bone Severe bleeding must be *controlled by cold compresses to prevent further escape of* fluid from the joint, and the joint can then be fixed with a compression bandage It is essential to compress the exposed joint capsule when this occurs in severe cases so as to prevent blood lymph or synovial fluid collecting in the tissues

Similar treatment is indicated for muscle contusions namely cold compresses and bandaging No bandage should be applied too tightly so as to hinder circulation. A complication of muscle contusion may occur in very deep muscle injury This is known as Myositis Ossificans Traumatica and is a condition in which bone fragments form in the muscle sub-

stance as a result of the injury I have known many cases of athletes who have developed this condition and in almost every case there has been some neglect by the trainer in the early stages It is a good rule that wherever a deep muscle bruising does not respond to treatment in a reasonable time, the case should be referred to a specialist as myositis may be suspected All cases eventually heal under skilled treatment

A frequent occurrence in footballers is a contusion of the shin bone, and wicket keepers often suffer from bone contusions of the palm of the hand or the tips of the fingers I saw a well known runner some time ago who had developed a bad bruising of the heel bone due to running on hard tracks Early treatment of bone contusions is the same as for other bruises though rest is sometimes indicated to prevent the possibility of further injury

Once the acute stage is over, all bruises may be treated by radiant heat and gentle massage. Do not massage over the actual bruise as this may damage the cells further but the surrounding tissue may be massaged to aid in the absorption of the inflammation. The galvanic current will be useful in reducing swelling and if short wave is available it can be used to assist in the stimulation of the lymphatics and circulation


Showing sprain of ligament of knee

Sprains are one of the most common injuries of everyday life and there is hardly any athlete who has not experienced one or more at some time or another A sprain of a joint is a tearing of ligaments which bind the joint but may also involve injury to the tissues supporting the joint muscles, tendons blood vessels or even to the bone covering itself (The membrane covering the bone is the Periosteum, meaning—peri—around, os—a bone.) A sprain is usually caused by any sudden wrenching or twisting of the bones of a joint The typical signs are pain and swelling and if the ligaments are badly torn the joint can

be moved farther than normal There is great local tenderness. The signs of damage depends on the location of the sprain for example, in the ankle or knee most of the stress is taken by the ligaments, while in the shoulder it is more likely to be one or more of the muscles It is a safe guide when a sprain is suspected to have an X ray picture taken. Some sprains are severe enough to need complete immobilization for a while, but in all cases elastic plaster bandaging should be done to prevent undue mobility and limit escape of fluid The first factor in the treatment of all sprains is to control the bleeding due to tearing of blood vessels and to prevent the large scale escape of fluid in the tissues The greater the escape the longer the athlete is incapacitated, and in all organized sports trainers are often racing against time to return an injured player to the team. The joints most frequently sprained are the ankle knee, elbow, shoulder and wrist, but sometimes sprains occur at the hip joints. In ankle joint sprains, the first concern is to reduce the swelling, by cold compresses, ice bags, or a cold bath of water The ankle should then be firmly strapped with elastic plaster bandage as shown in the chapter on strapping technique. Short wave should commence twenty four hours later and the bandage removed and re applied after treatment Thirty minutes short wave can be followed by galvanism in a special form known as ionization.

The technique of this is simple and can be briefly described The ankle is painted with tincture of iodine and the electrode attached from the negative terminal of the galvanic apparatus is wrapped in a moist cloth and strapped round the ankle. The other electrode can be placed on a convenient part of the leg close by Both electrodes should be well wrapped in warm moist cloths soaked in saline solution and should be about half an inch thick. This will effect deep penetration and so assist in the absorption of the effusion About twenty minutes ionization is sufficient This treatment should be done daily or twice daily if possible and the plaster bandage re applied each time. Encourage the athlete to walk if there are no further complications as the joint motion and muscle contraction will hasten clearing the inflammatory products After a day or so mild faradism can be tried to stimulate the muscles and gentle massage and movements Many thousands of cases have been treated in my clinic in this manner and in each case the athlete was fit in a week or ten days.

Sprains in other joints can be dealt with in a similar way, and I have found it to be of very great benefit in Tennis Elbow and Cricketer's Arm. Severe muscle exertion often brings about these well known conditions, where there is pain if you try to extend the elbow joint or twist the forearm, and the elbow joint swells. In recurrent cases there is often an arthritis of the joint. This can be prevented by the treatment outlined above.

Many authorities disagree with the use of any form of heating in the treatment of sprains or strains, but experience has shown that short wave and the ionization already described is invaluable for the quick and effective reduction of swelling and promotion of absorption. Graduated muscular exercises and light massage are also helpful. I have no hesitation in recommending the treatment outlined for I have found it effective in so many cases that I am content to let the results speak for themselves.

Excessive stretching or "pull" of a muscle is known as a *strain* and the tissue is torn at any point in the muscle. The degree of tear varies from a mild tear of a very few fibres to a complete tear or rupture of the entire muscle or tendon. As a result there is injury to capillaries and blood vessels with bleeding.

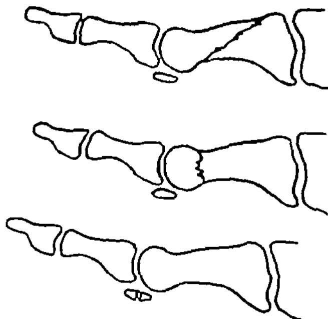
The first sign of a strain is acute pain followed by loss of function of the muscle involved. A strain should always be suspected when pain is felt if a muscle contracts against resistance, and when tenderness occurs over the muscle or its tendon. In severe strains some adhesion may be formed and as a consequence there may be a stiffness in the muscle or the group of muscles concerned with a movement. Complete tears are not so common but if they happen surgery is advised. All treatment of strains should be the same as that already outlined for sprains. It is essential to preserve muscle tone, and prevent the formation of adhesions. In addition to the physical treatment strapping is always useful as it gives confidence to the athlete to use a muscle when he would otherwise be chary of doing so.

There are many instances of stiff joints following sprains and this occurrence, which sometimes leads to traumatic arthritis of the joint, is often a serious one with athletes. There is very often a flabbiness of the muscles, and early treatment by physical measures will prevent most joint stiffness.

If, however, stiffness is present care must be taken to see

that no bony block exists. If there is serious destruction of cartilage or a deformity of a joint surface, physical measures should not be tried and an X ray taken immediately

The principle of all treatment in suitable cases is to limber up the fibrous contracted tissues. All physical means can be employed in the conditions referred to so far, short wave, galvanism, massage with long stroking movements, and graduated muscular contractions with either faradism or galvanism *(interrupted or surged), but care must be taken not to* apply too vigorous measures or a severe reaction will follow Remember that you have a human body to treat and apply all treatment with diligence, care and intelligence and excellent results will follow

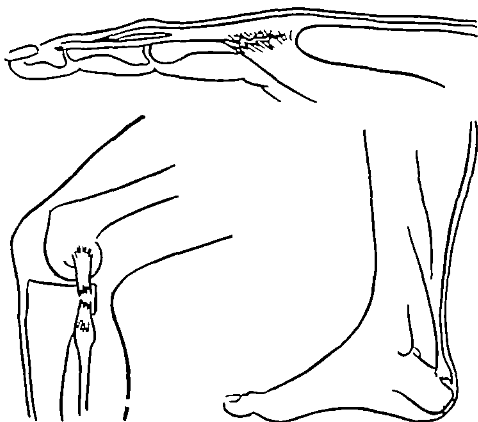


This drawing shows three separate types of fractures due to stress in athletics, and have been found to be common in athletes using their feet with force particularly in jumping and running on hard surfaces.

Though strictly speaking *Fractures* and *Dislocations* are not the concern of the trainer for treatment in the early stages, yet there are no injuries which worry the trainer so much because of the time lost to the sport by an athlete.

In a dislocation there occurs a rupture of the joint capsule at its weakest point. Immediate reduction is necessary and this

is the concern of the club doctor If there are no complications physical treatment can be started immediately following reduction The muscles acting upon the joint are damaged and lose tone. Heat, gradual muscle exercises, and massage are beneficial to promote absorption and relax muscle spasm If adhesions are formed gentle friction movements around the



Demonstrating sprains of the finger knee and ankle.

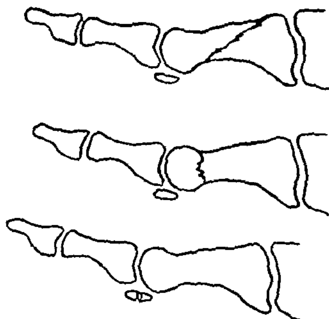
joint are indicated The joints most commonly dislocated are the shoulder fingers, and elbow but sometimes an ankle disloca tion occurs though this is very seldom. There is often a mild dislocation of the knee joint and this may be treated as a severe sprain.

It is essential to see that no movement takes place at a joint to cause a re-dislocation so that effective strapping should be applied or if the shoulder is affected a sling can be worn

Hardly any bone in the body has not at some time or another been subject to fracture in the history of games Obviously the treatment of fractures belongs to the surgeon, but the trainer should be able to undertake effective measures All fractures

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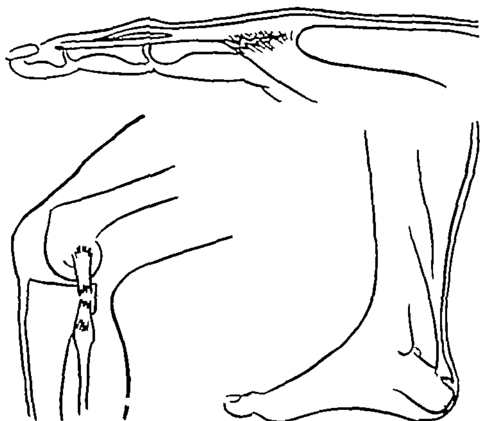


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Demonstrating sprains of the finger knee and ankle

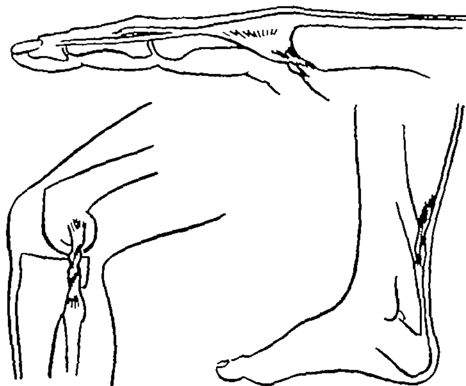
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should be carefully splinted and the athlete removed to hospital immediately

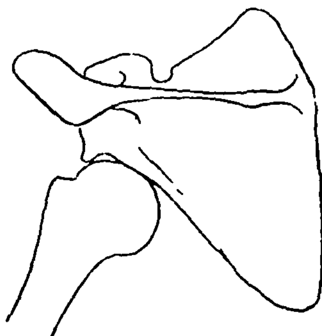
After treatment is concerned with preventing wastage in muscles and treating stiffness which follows long immobilization Physical treatment can be given while the limb is still in plaster but this is the surgeon s province and he will certainly make the necessary arrangements It is when the athlete returns



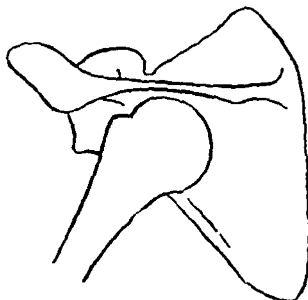
Demonstrating strains of the finger knee and ankle.

to the care of trainer that he can receive any follow up treatment which may be advised and physical measures will almost certainly be prescribed to continue for a while

In view of the large number of games played and the thousands of athletes who play them it is perhaps surprising how few internal injuries occur In the past twenty years only three serious injuries in ball games have been sustained which have resulted in death two of these being goalkeepers in Association Football and the other a Rugby player In boxing perhaps half a dozen have occurred Of course I am not counting the deaths in motor-cycling racing which is a field of its own and does not compare with ordinary athletics or sports



Normal shoulder joint showing the head of the humerus lying in the cavity of shoulder blade



Showing the result of mismanagement. A slight dislocation has now been worsened so that the head of the humerus lies completely under the spine of the shoulder blade

participation where the athlete relies on his physical prowess and not on that of a machine.

Of all forms of internal injuries perhaps concussion is the most common It happens in both football and boxing, and is the result of an injury to a part of the brain following a blow on the head It may occur with either partial or complete loss of consciousness. In the mild type, the athlete is knocked down but immediately recovers and regains his intellectual functions and initiative. In another form he may be knocked down or receive a blow and he loses his awareness of his surroundings. He may stagger but never lose complete consciousness. For a moment he is out on his feet In a third type the athlete is knocked down and is completely unconscious. The period of unconsciousness may last from a few minutes to several hours. When he recovers he may complain of headache, dizziness and sickness and may lose all sense of his surroundings. His intel lect is subnormal In this case there is always the possibility that a contusion of the brain may have occurred

The athlete who suffers repeatedly from concussion is referred to as punch drunk Perhaps an actual brain injury exists. Many boxers receive blows on the head and in a very few cases these have resulted in death In other cases boxers are subjected to heavy punishment about the head and yet go on fighting for many years. Unfortunately it is not possible to examine the brain with a microscope and ascertain the extent of injury after each fight or to learn just what damage each blow has done. A boxer under these conditions may act as if less and less injury and the lightest of blows produced short periods of unconsciousness or at least an inability to co-ordinate his brain and muscular movements The question that should be asked in these cases is whether such an athlete should be allowed to continue taking part in boxing matches. The answer is obviously in the negative, yet it still happens, and the authorities who govern the sport must seriously concern them selves with this matter and ensure that after even a mild concussion boxers are medically examined and regularly re examined so that the degree of injury may be properly assessed

The treatment for concussion is rest in bed preferably in hospital where skilled nursing is available. It cannot be assumed that no skull or brain injury will not occur, the fact that they do occur is sufficient knowledge that prevention and adequate medical attention must always be provided



Fracture of the collar bone near its mid point, with the usual downward angulation (Football injury—Association.)



Fracture of the spinous process of the sixth cervical vertebra (Football injury—Rugby)

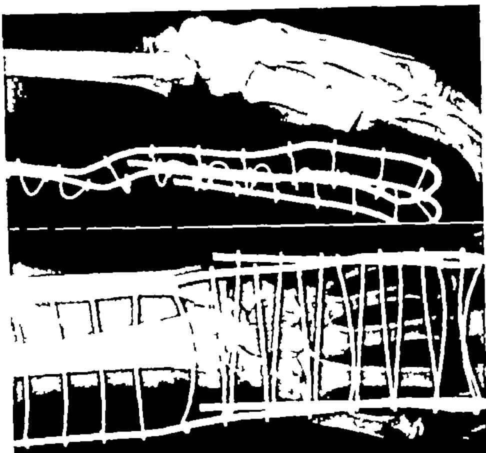
Sometimes a fracture of a rib has been known to injure an organ in the chest. Sometimes the lung has been penetrated but as the occurrence is so rare and in any case is the province of the surgeon it is not necessary to further discuss the injury though every trainer should be aware that such a thing can happen.

Injuries have been known in the abdomen by a blow on the abdominal wall from a football which ruptured the bladder As this is only possible when the bladder is full all athletes should be warned by the trainer to empty the bladder before any participation in games It should never be possible to have a bladder full enough to rupture. Sometimes an injury occurs in the spleen and the kidneys and the trainer should be suspicious of all pains or cramps in the abdomen and call them to the notice of the club doctor

Possibly one of the most irritating affections which can happen to any athlete is the common or garden blister Blisters of hands and feet occur frequently all through the season and treatment is simple. They should be carefully incised with a sterile instrument and the water drained A small plaster dressing is usually sufficient. Athlete's foot is a fungus infection due to invasion of the skin by a mould like organism. It is usually found on warm, moist feet between the toes, but it can be on the soles or even in the groin. Complete text books have been written about this one subject. It should always be treated as a serious infection and if on the feet a foot bath can be made up of one per cent solution of sodium hypochlorite and the feet soaked for ten to fifteen minutes. Another form of solution is one per cent copper sulphate. In both cases the solution should be made up fresh for each person and each treatment. Do not let two athletes soak in the same foot bath. If the infection is on other parts of the body a daily painting of mycozol or a strong solution of iodine (tincture iodine fortis) is very often beneficial A very valuable dusting powder is one consisting of equal parts of pulverized calomel, starch and zinc oxide.

Many athletes have skins which are sensitive to plaster and a precautionary measure is to strap the plaster bandage over a cotton one. Plaster may also be applied with the sticky side on the outside.

Inflammations often occur in tendons and muscles and one condition in which the sheath of the tendon is affected has already been referred to This is tenosynovitis, which is an



Fracture of the lower end of the radius There has been much splintering of bone and displacement (Football injury—Association)

inflammatory reaction often occurring after injury but sometimes following an infection. The condition is noted not so much for the pain but because of the weakness when attempting to bring the tendon into play A crackling sound may be heard *which is due to deposits of fibrin between the tendon and the* sheath. Sometimes there is marked swelling In chronic cases hard tissue forms between sheath and tendon and develop adhesions which interfere with the action A condition of this kind occurs in the long head of the biceps muscle in the upper arm and is known as golfer s shoulder The first consideration is rest with support for the part. Massage should be avoided until healing takes place but short wave and galvanism is of great benefit with effective strapping to ensure a minimum of work to the injured part.

A bursa is a sac filled with fluid found in parts of the body where there is repeated pressure and under muscles, tendons and the moving surfaces connected with a joint These are very often the site of injury Footballers often injure the bursa under the lower part of the knee cap, and this has a common name known as housemaid s knee All bursae react to physical treatment, with compression bandaging in the early stages, and rest Later on more vigorous methods may be used such as muscular contractions exercises, with heating and galvanism

An inflammatory reaction in muscle tissue is common as the result of direct injury This is known as myositis and because of the tenderness the muscle is held rigid Myositis is in the same group as fibrositis and the treatment is simple—heat, gentle massage and rest in the beginning and radiant heat or short wave, galvanism and faradic contractions to counteract the stiffness In chronic cases the pain may not be so sharply dis turbing when the muscle is working Some medical writers have described this condition as myofascitis (an inflammation of the fascia or underlying structure) and have traced its cause to a toxic condition. The treatment of chronic myositis may therefore be planned towards relief of the condition in the muscle itself and at the same time from a constitutional point of view Teeth may be examined for signs of infection. There is a great resemblance between chronic myositis and a chronic fibrositis so that no harm is done by a check up Where there are very stubborn adhesions the most satisfactory treatment is large doses of galvanism followed by friction movements over the whole muscle or muscle group

CHAPTER XVIII

LOCALIZED INJURIES

THE distribution of injuries in various parts of the body lead to certain conclusions that some regions of the body are more susceptible to injury than others Conversations with various trainers show a difference of opinion as to which of the body regions is more prone to suffer injury, but my opinion is strictly that experience has proved that injury is only common to a localized area of the body when that region is the one most used in any sport For instance, ankle, knee, and thigh injuries are very common to footballers, sometimes happen to boxers, but are almost unknown to rowers, runners and wrestlers Again, head injuries are common to boxers, less so to footballers, but almost unknown to cricketers, track athletes, and most players of ball games

This does not mean that if you play a certain game or indulge in certain track events you will escape injury in those regions not used, for some regions show a common consistency in all sports and of these probably the ankle, knee, shoulders and thighs rank the highest in the necessity for treatment during any athletic season

As a matter for discussion only, and for reference, it will be seen that careful examination is necessary whenever an injury occurs in any region, but perhaps a little more discussion and detail of local injuries will not be out of place. Though this chapter may contain much of what has already been said under other headings repetition will do no harm if it assists the trainer to remember the points I have attempted to establish

Injuries of the head, neck and face are still a fairly large proportion of all athletic injuries and may vary from a simple abrasion to a serious internal injury of the head, causing concussion, contusion or even laceration of the brain. Injuries to the nose eyebrows, cheeks and ears, are very common to boxers, and the first thing is to control the bleeding if not too serious, with an adrenalin pack. Though a cauliflower ear was once a very prized possession by boxers, proclaiming their active association with the noble art, it is nowadays considered

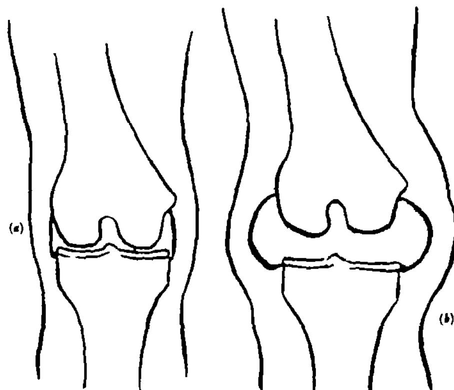
inflammatory reaction often occurring after injury but sometimes following an infection. The condition is noted not so much for the pain but because of the weakness when attempting to bring the tendon into play A crackling sound may be heard which is due to deposits of fibrin between the tendon and the sheath. Sometimes there is marked swelling In chronic cases hard tissue forms between sheath and tendon and develop adhesions which interfere with the action A condition of this kind occurs in the long head of the biceps muscle in the upper arm and is known as golfer s shoulder' The first consideration is rest with support for the part. Massage should be avoided until healing takes place but short wave and galvanism is of great benefit with effective strapping to ensure a minimum of work to the injured part.

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chest A broken rib may penetrate a lung and it is better to be safe than sorry

Shoulder injuries are also fairly common ones, and may consist of fractures, dislocations, sprains or mere bruising Treatment consists of effective strapping, massage, heat and other physical means in the case of sprains and contusions, while fractures and dislocations are the responsibility of the doctor After treatment for these conditions has been discussed



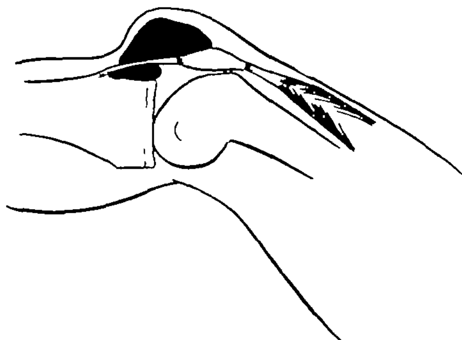
Showing normal knee joint (*a*) and injured joint (*b*)
Note increase of joint space to accommodate fluid

Fractures of the arm are not very common in sport and apart from minor strains or tennis elbow and cricketer s arm injuries are less common than would be supposed Treatment of these conditions has already been discussed and does not require further elucidation

Local injuries to the wrist hand and fingers are fairly more frequent Again we may have a simple bruising or abrasion, or a serious fracture In the case of fractures in these regions immobilization is usual until a solid bony union is made, and physical treatment may be started as soon as possible and con

entirely unnecessary Boxing is now respectable and the boxer prefers to show his proficiency by a belt round his waist or something in the bank. Cauliflower ear is caused by superficial bleeding between skin and cartilage and is treated by prompt removal of the blood and fluid (known as aspiration) and compression strapping

Injuries about the eye can be serious if not properly and promptly attended to and may result in blindness Dirt track riders suffer from *cinders in the eye and a thorough irrigation* using an eye bath is essential Cinder burns and abrasions may



A typical knee injury Note the swelling giving a housemaid s knee effect.

be treated with olive oil lightly massaged in and around the part and all dirt removed If a serious injury ever arises in any sport it is advisable to seek the advice of a specialist Broken teeth should be seen by a dentist and any internal injury to the gums or cheek or tongue is a matter for medical assistance

Fractures of the ribs are fairly common and they require immediate strapping as shown in the chapter specially devoted to this technique Injuries in the chest region may be a simple strain, muscle bruising or fracture of the breast bone, but in all cases it would not be out of place to view any chest injury as serious until you are sure. In these cases I always have an X ray done so as to exclude any injury to one of the organs of the

described in a previous chapter The incidence of injury in this region will then be lessened and a load of worry lifted from the trainer

Treatment of knee injuries consists first of rest and adequate and effective strapping to prevent excessive weight bearing Cold compresses or galvanism can be given together with compression strapping Though massage is not advisable in the early stages short wave is useful to assist absorption of the fluid Exercises of the quadriceps muscles as already described can also be given and they should continue until normal function returns. A cartilage that is displaced whole may be replaced by simple manipulation, but if the cartilage is torn so that part of it is loose within the joint, it may act as a loose body and so jam the joint, causing a locking In these cases surgical help may be necessary

The most common type of ankle injury is the sprain which accounts for about three-quarters of the total number of injuries in this region The Achilles tendon at the back of the heel is another fairly common site, but treatment is the same as described for knee injuries with strapping and pads of felt or rubber secured by a stirrup of elastic plaster bandage, and completed by a complete figure eight bandage from toes to just above the ankle bones

tinued until full power and function is restored. Sprains are treated as shown previously but strapping is useful.

Possibly every known form of injury can occur in the abdomen, pelvis and back. A very common injury to the abdomen is a blow in the solar plexus, which is known as being winded Actually the blow will cause paralysis in the diaphragm so that all respiration ceases Many trainers treat this condition by laying the athlete flat on the ground and by using the legs as pump handles try to pump air back into the unfortunate sufferer *This is the worst type of treatment and should never be attempted.* The player should be placed in a restful position, told to relax and all tight clothing belts etc loosened He should be told to take quiet short breaths If normal respiration does not return in a few minutes, artificial respiration should be given, though I have never known this necessary

One of the most interesting occurrences usually in runners though not unknown in footballers is stitch It is interesting because it invariably occurs in the right side. The reason in most cases is muscle cramp but in many cases of recurrent stitch, examination has found the athlete to be constipated. Though it must not be taken for granted that all recurrent cases are caused by constipation athletes will do well to bear this in mind and see that the bowels are regularly cleared before sport participation.

Thigh injuries are common and number about fifty per cent of the general treatments in any trainer s experience. The front of the thigh is more subject to injury than the hamstrings at the back but these would occur less if a thorough warming up is given prior to the game. The Charleyhorse is a rupture or contusion of the thigh muscle and is very high in ice hockey players but it responds very quickly to routine treatment.

Of all the joints in the body the knee is probably the most difficult and most liable to injury In examining injuries of the knee it is important to ascertain just how the injury occurred. Try to find whether it was caused by a direct blow such as a kick, or a wrench or twist

I have often observed in athletes how under-developed the muscles are which control the knee. This is because no exercises are aimed at, or carried out in order to develop these muscles. Probably only in rowing and cycling are these muscles properly developed but as they are important in all athletes proper development must be carried out by exercises which have been

bleeding may flow briskly and then ease off into a mere ooze, but the blood is red The first essential is to stop the bleeding, clean away the grit and dirt and apply iodine and cover with a dressing A small wound will soon clot and this is Nature s method of stopping the flow of blood, but if the bleeding is more persistent cold water and pressure round the area will soon stop it If a player bleeds from the nose sit him down and with head thrown back loosen any tight clothing Instruct him to breathe through his mouth and if water is handy apply cold over nose and nape of neck and then plug nostrils with cotton wool Warn him not to blow his nose for a while.

Bruises may occur anywhere and can be treated with cold water and iodine and covered by a plaster dressing

Should a boy receive a blow to render him unconscious lay him on his back and turn his head to one side. If his face is pale keep the head and shoulders low and raise the feet, but if the face is flushed raise the head and shoulders When he recovers small sips of water may be given If consciousness is delayed or breathing is hardly discerned, artificial respiration can be tried, but it is essential that medical assistance be obtained in such a case

Sprains and strains may be treated by cold water bandages and strapping until effective treatment is available, and a fracture can be splinted (many things are adaptable as splints, walking sticks and so on) until removed to a hospital If a dislocation occurs do not attempt to reduce but seek medical aid.

Most of the treatment outlined is common sense but there may be many instances when they prove necessary

CHAPTER XIX

FIRST AID TREATMENT IN INJURY

So far we have discussed the treatment of injury which is likely to occur in athletics of a highly organized nature. Though these are numerous it may be as well to consider the other side of games and sports, and this is the vast number of young people who take regular part in athletic events games and various pastimes, and are associated with boys and youths clubs, schools works teams and so on. They are generally referred to as the Saturday afternoon sportsmen and as they constitute probably the greatest proportion of all participators it would not complete the work I have in mind if proper attention was not given to them and their needs.

The people responsible for the welfare of these young people are often men and women who have a full time job in some other sphere and yet give up a great portion of their leisure to look after the interests of these aspirants of athletic fame.

In order to assist them should they be confronted with any type of injury this chapter has been written.

All games and sporting events have not the advantage of a member of either the Red Cross or St. John s Ambulance Brigade in attendance so that every youth leader or club warden or schoolmaster should have a first aid box handy This should contain antiseptic such as Dettol tincture of iodine, a small bottle of eye-drops and eye bath, a variety of dressings cotton wool small bottle sal volatile or smelling bottle, one or two bandages to be used as slings roller bandages, elastic plaster bandage (in one inch and two-inch rolls) aspirin, and safety pins and scissors. This list is not comprehensive but contains all the essentials It can be added to to suit individual requirements

The most likely type of injury is either an abrasion or laceration in a game of football or from a fall on the running track. These wounds are usually dirty and dirt and grit often gets in It is easy to tell whether the bleeding is from an artery *a vein or a capillary by the colour If an artery is cut the blood* is bright red and jerks out from the wound Blood from the vein is dark red and flows in a steady stream, while capillary

Fig 1a.

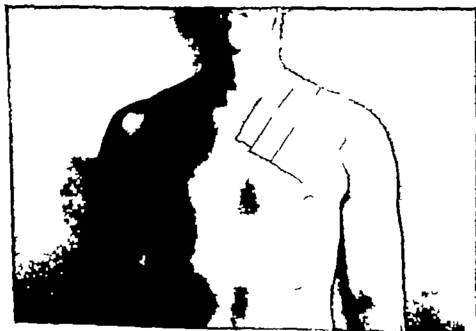


Fig 1b.

CHAPTER XX

STRAPPING AND PADDING TECHNIQUE IN INJURY

So many occasions arise in which effective strapping and padding of injured parts are necessary that very few trainers get through a season without their use. This chapter has been written to provide the best known and most useful methods in which elastic plaster bandage may be applied either with supporting padding or by itself.

Strapping techniques involving every type of injury have been specially photographed and the trainer will be able to see at a glance the best way in which to apply any form of strapping from a simple first aid bandage to a fractured separated patella.

This chapter may be used for continual reference and can be carefully studied as it is never certain when it will become necessary to apply the lessons described in the text and illustrated in the adjoining photographs

Fracture of the Clavicle (Collar-bone) To fix a pad in the arm pit as demonstrated and retain pressure over the collar bone, apply an elastic bandage as illustrated (Fig 1*a*) As an alternative method or in severe cases after removal of any apparatus, strips of elastic plaster bandage overlapping each other afford firm support (Fig 1*b*)

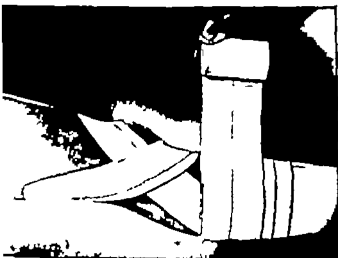
Fractured Ribs Bandage with elastic plaster bandage, cummerband fashion if possible. If unable to encircle the body completely apply strips which should be as long as possible well over and beyond the site of fracture. Use a moderate degree of tension in both cases Apply each layer or turn of plaster at the moment when the patient has breathed out fully The same strapping may be used for bruised ribs (Fig 2)

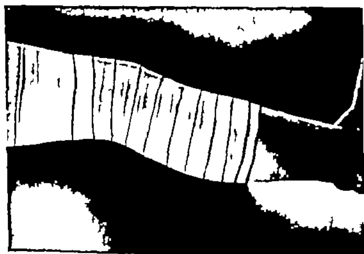
Fractured Knee-cap (Patella) This is for a transverse fracture, cracked across without separation of the broken ends After the knee joint has been aspirated (removal of fluid) an elastic plaster bandage should be applied in three places

(*a*) as an inverted U above the knee-cap

(*b*) as an upright 'U below the knee-cap, and


Fig 2.


Fig 3a.


Fig 3b.

(*c*) in circular turns from the middle of the calf to six inches above the knee (Fig 3*a*)

Joint Effusion (Swelling), Knee-cap, Following Fracture After the removal of a plaster cast there is no finer support than elastic plaster bandage to prevent further swelling and to support the knee and give confidence in the early stages of movement It also acts for compression should swelling be present Should a restricted movement be desired at first a generous wool padding under the bandage will hamper the knee movements to the degree required (Fig 3*b*)

Displacement of Semi Lunar Cartilage One of the most frequent injuries in football is the displaced semi lunar cartilage. After reduction apply elastic plaster bandage firmly over the knee and well above and below It is often helpful to first apply a strip lengthwise at each side of the knee-cap A pad of several layers of gauze at the back of the knee will prevent chafing This is advisable when the bandage is to be left on for a long period after the cartilage has been replaced (See Fig 4*a*. Fig 4*b* shows bandage completed)

Tailed Bandage for Knee Injury This illustrates an alternative method of knee strapping and one which gives great flexibility of movement. Cut down the middle of a one yard by three inch strip of plain elastic bandage leaving about six inches uncut. Apply the uncut end to the side of the knee, then over the knee cap and then bandage with the strips above and below The back of the knee should be left entirely open. Each layer should overlap the previous layer The length of the strip depends upon the amount of support required and if necessary full width strips may be bandaged below and/or above the joint. Any tendency for the overlapping edges to curl when the patient is dressing can be prevented by applying a final lengthwise strip (Figs 5*a* and 5*b*)

Mallet Finger This is very common in cricketers and boxers It is a convenient method of applying hyper-extension to a torn extensor tendon

1 A strip of elastic plaster bandage one inch wide and about ten inches long is applied to the palm along the whole length of the injured finger leaving about five inches of the plaster hanging loose over the finger end

2 A piece of *extension* plaster one and a half inches wide and about twelve inches long is slit for half its length and applied to the back of the hand and along the injured finger so that the

beginning of the slit portion is immediately over the terminal joint of the injured finger

3 A one inch cotton bandage is placed on the junction of finger and palm and the two ends of the extension plaster pulled down tightly and adhered to the palm, leaving the finger end free. This bends the finger over the cotton bandage and holds it in flexion as far as the terminal joint

4. Pull back the free end of the one inch elastic plaster bandage until the required tension is obtained and stick it to the back of the hand Both plasters are held in position by an encircling strip of elastic plaster bandage (Figs 6a and 6b)

Sometimes a bandage strapped tightly on the leg is difficult to remove so that a length of tape placed down the leg before the bandage is applied will be found useful in facilitating removal and may prevent cutting the skin The ends should overlap a few inches and these are pulled away from the legs to provide entry for the scissors (Figs 7a and 7b)

Longitudinal strips of plaster bandage in the form of splints or as side stirrups going under the arch of the foot are useful as they also prevent cutting into the skin This can be used as a back stirrup to prevent creasing of the wound bandage, particularly in the region of the Achilles tendon (Fig 8)

Many cases where bandaging is prevented by extreme tenderness of the skin can be overcome by using the bandage reversed, that is sticky side out. The bandage may be secured to each end by a small piece of adhesive strapping used in the ordinary way The stickiness can be removed by rubbing with talc (Figs. 9a and 9b)

An effective way of relieving pain in a strain of the ankle is by applying strips of adhesive sponge rubber or felt about one half an inch wide and two and a half inches long to the depressions of either side of the tendon at the back of the heel (Achilles tendon) and curved round and below the protuberances on either side of the ankle bones An elastic plaster bandage is then applied over the sponge rubber Swelling is soon controlled and blood clots are prevented from forming in the tissue (Fig 10)

For a simple strapping and padding to relieve the strain of flat foot or a strain on the muscle of the front of the legs, or as a support after manipulation cut a suitable pad of felt or sponge rubber The edges should be carefully skived down as shown, and if necessary use more than one layer Place the pad in position



Fig. 4a.



Fig 4b.



Fig 5a.

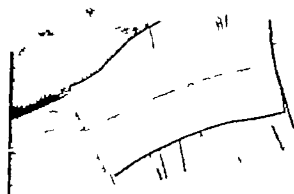


Fig 5b.

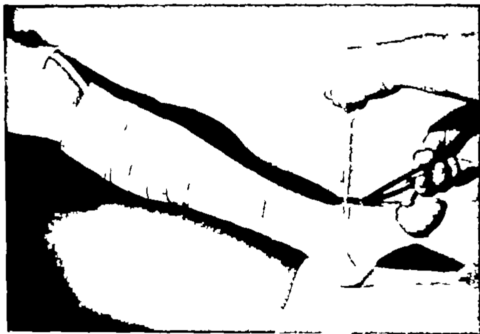


Fig 7b



Fig 8.

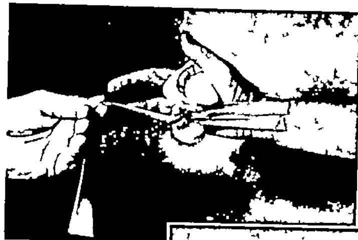


Fig 6a.



Fig 6b.



and bandage with firm strapping which keeps the pad in place. The assistance of the pad is extremely comforting on weight bearing (Figs. 11*a* and 11*b*)

Knee or Elbow Support A simple figure of eight method of application to the knee is illustrated, which can also be adapted to the elbow A length of two and a half inch elastic plaster bandage is used (Fig 12)

Joint Effusion Where there is a great deal of swelling use strips of bandage as shown (Fig 13) Apply firm strapping over the whole joint, and if necessary a soft pad behind the knee will prevent chafing if the bandage is to be left on for any length of time.

Synovitis An elastic plaster bandage as shown (Fig 14) applied firmly over the joint and for some distance above and below will help to control the accumulation of fluid in cases of simple synovitis. It also provides warmth and support in several conditions where this is considered necessary

Tennis Elbow An excellent method which provides the support required and in no way restricts movement is illustrated (Fig 15) First cut down the middle of a length of elastic plaster bandage, three inches wide by twenty four inches long, leaving about six inches uncut. Apply the uncut end to the outer side of the joint, then over the point of the elbow and continue with the cut ends above and below overlapping slightly at each turn If particularly firm support is required, additional width strips may be applied above and below the joint.

A similar method for the knee is also shown Cut down the middle of a one yard strip of plain elastic plaster bandage leaving about six inches uncut Apply the uncut end to the knee over the patella and then bandage with the strips above and below The back of the knee should be left open Each layer should overlap the previous layer The length of the strip is dependent upon the amount of support required and if necessary full width strips may be bandaged below and/or above the joint Any tendency to overlapping by the edges making them curl may be overcome by adding a full length strip This method may be also applied to tennis elbow or other elbow injuries if a full and firm support is required

Fractured Patella (Knee-cap) In this condition it is sometimes usual to delay operation until bleeding into the joint has stopped During this time the quadriceps muscles down the



Fig



Fig 9b



Fig 10.

front of the thigh may undergo some shortening, especially if there is wide separation of the fragments of the bone. In order to prevent any difficulty at operation in approximating the two halves of the patella a simple figure of eight bandage as shown in Figs 16a and 16b is of considerable help

Strapping for Sprains and Strains of the Ankle These injuries are of so frequent occurrence that an effective method of strapping which will assist in the return of the athlete to active participation as early as possible is vitally necessary The strapping should be efficient and done in time, and a well tried method is shown (Figs. 17a, 17b and 17c), in three stages.

Stage 1 (Fig 17a) A piece of adhesive sponge rubber or felt about three inches long and two and a half inches wide is cut into the shape of a U', the space between the legs being sufficient to accommodate the protuberances on either side of the ankle. The pad is applied with the open end towards the extremities, and the edges carefully skived down.

Stage 2 (Fig 17b) Two or three pieces of one inch elastic plaster bandage overlapping each other by half of their width are applied on the inner side from about the lower third of the tibia, under tension under the heel and up the outer side of the leg to cover the pad completely and leave an overlap of an inch or two The object of this is to correct the direction of strain. This is assisted by the patient holding a cotton bandage as shown and pulling gently to the outer side.

Stage 3 (Fig 17c) The two and a half inch width of elastic bandage is applied under a fair degree of tension from the toes to the lower third of the leg with a figure of eight to accommodate the heel.

Fractured Patella (Without separation of fragments) This crack type of fracture may occur as a result of a blow over the knee. There is no rupture of the thigh muscles or separation of the bone and therefore operative intervention is unnecessary It is advisable, however to immobilize the knee and this may be carried out effectively by the method shown.

After the knee has been aspirated (the fluid removed) an elastic plaster bandage should be applied in three places

(a) as an inverted U above the patella

(b) as an upright U' below the patella, and

(c) in circular turns from the middle of the calf to six inches above the knee (Fig 18)

Pressure Bandage This may be necessary at any time, and

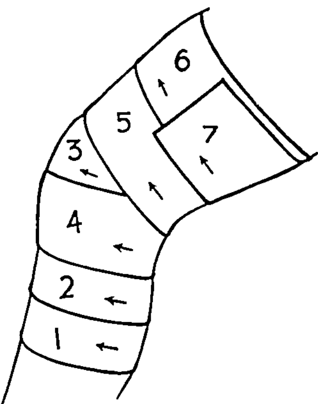


Fig 14.

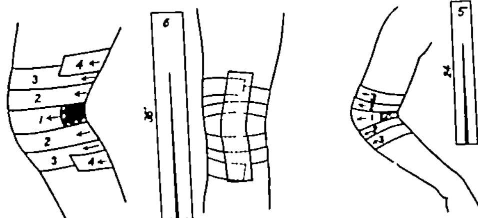


Fig 15

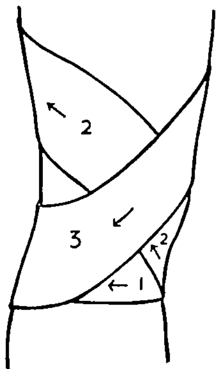


Fig 12.

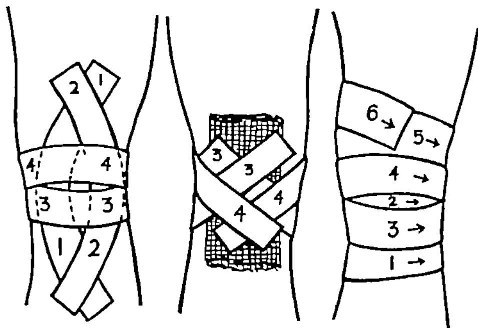


Fig 13

Fig 16a

Fig 16b.

must be applied so that it will remain in position Bandages may have to be applied to the schoolboy who has fallen and cut and grazed his knee, for the player who has strained a joint so as to cause considerable swelling, or in the condition known as 'housemaid's knee You will notice that all these conditions apply to the front of the knee Often a bandage may be required at the back of the knee after an abscess has been opened or a bursa removed, sometimes after the treatment for varicose veins, or for operations in the joint space. The inner side of the knee may need a pressure bandage following removal of an internal semi lunar cartilage, and a bandage so applied will brace the inner side of the joint, as for example, in the athlete who has strained or torn the internal lateral ligament.

It is a general principle in knee joint injuries to keep the patient on the move, and yet it is common practice, following injuries or infections about the knee, to put the patient to bed after applying a back splint, and tell them to rest and not move. The application of a bandage which will apply pressure in the place needed and yet still allow movement, is of great value in assisting the recovery of the patient with all knee injuries The following method, once the principle is grasped, is both simple in application and effective in use.

Application to front of knee To bandage the front of the knee the patient should sit with the heel of the injured leg resting on a chair or foot rest or held by an assistant. The knee is therefore extended or it may be slightly flexed The first step in the application of the bandage is to apply two complete turns round the leg below the knee—the first an anchor turn—leaving a commencing tab with which to tie-off the bandage eventually The bandage is then taken upwards, across the knee-cap completely round the thigh above the knee, and is then brought downwards across the front of the knee in the opposite direction to the first cross and then fixed by a complete turn round the leg We now have a complete cross, which intersects over the knee-cap Continue bandaging, forming another cross from below upwards fixed with a complete turn round the thigh and so on until the two bandages are completed (See Fig 19 Illustrations 1 2 3 and 4)

Alternative bandage A useful alternative which increases the pressure is by added layers of cotton wool between each cross over of bandage. A bandage of this type can be put on very tight with complete comfort to the patient, and sustained pressure is

exercised without preventing movement This type of bandage is sometimes known as a Sir Robert Jones' bandage, and is used extensively where the player's skin is sensitive to plaster Naturally the bandage should be re applied daily, sometimes oftener, as there will be progressive reduction of swelling which will loosen the bandage

Application to the back of the knee The patient can lie face downwards, but the method is exactly the same as above with the exception that each crossing of the joint from below upwards and vice versa must be fixed by an anchor turn round the leg and thigh

Applied in this manner the bandage will hold the dressing in position with pressure and security and leave the front of the joint free for movement thereby maintaining the muscle power

Application to the side of knee A pressure bandage is often needed to the side of the knee, frequently to the inside and less often to the outside The position of the limb for the application of the bandage to the inside of the knee is one where the foot rests sideways on a chair or is held, the patient lying on the same side as that of the limb to be bandaged The good leg is bent forward or backward out of the way Apart from the great comfort this bandage also relaxes the ligaments on the inside of the joint so that the criss-cross bandage, with the pressure it will exercise, is invaluable for a strained internal lateral ligament. Two bandages are required and are applied precisely as already described for the front or back of the knee, except that the crosses of the bandage now centre over the inside or outside of the joint as required, instead of over the knee-cap or the space at the back of the knee Once the principle of the application of these bandages has been learned, i e. that two bandages are required and that every cross must be fixed above and below the joint by anchor turns, full satisfaction is assured to the athlete It is surprising how often these anchor turns are omitted, even by those who have previously had instruction.

Knee Effusion In the case of a strained knee joint it is necessary to provide support at the earliest opportunity in order that escape of fluid and swelling can be controlled This support may be obtained by bandaging firmly with Elastocrepe. Sometimes the bandage can be applied in conjunction with cotton wool Pad liberally round the knee joint and then bandage firmly (Figs 20*a* and 20*b*)

Ankle Strains When these take place a pain of lightning'



Fig. 17a.



Fig. 17b.

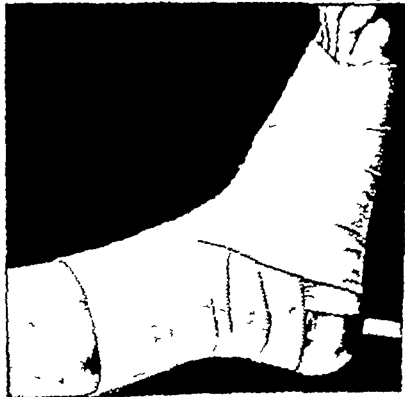


Fig. 17c.



Fig 20a



Fig ob.

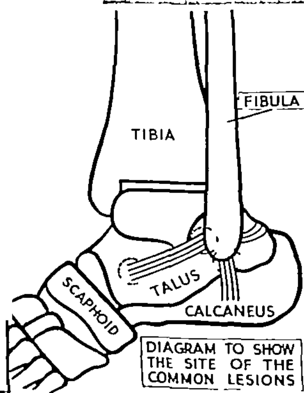


Fig 21a.

Fig 18

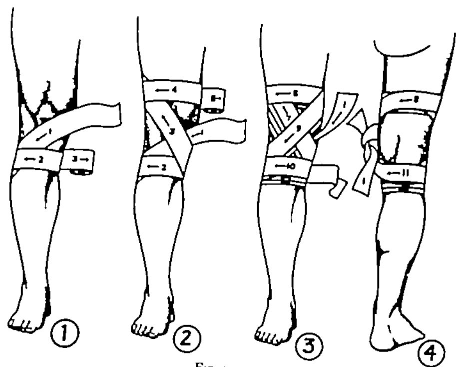


Fig 19.

character seems to spread up the leg Instantaneously the muscles controlling the joint go into spasm and the abnormal position of the foot and ankle is corrected Usually walking is easy immediately after the injury but before many minutes elapse weight bearing gives rise to pain Soon the ankle begins to swell and walking becomes increasingly difficult The diagnosis of the site of the strain may not be too hard to as certain, if you bend the foot downwards and press gently on either side of the ligaments under the protuberances of the ankle. The pressure will elicit pain which will give you the exact site of the injury Common sites of strains and sprains of the ankle joint are illustrated (Fig 21*a*) To allow the injured fibres to heal they should not be subjected to ordinary stress in walking or running Only very severe *sprains* need rest in bed until swelling has subsided The object of all treatment generally is to permit free movement and at the same time limit the movements of the ankle joint so that injured fibres are not pulled open. If it is necessary to guard ligaments on the outside of the ankle against repeated strains pad and strap as in Fig 21*b* The ankle and leg can then be strapped with elastic plaster bandage and continued until all tenderness has disappeared (Fig 21*c*)

Sprained Ankle Treatment in all sprains aims at preventing stretching the injured ligaments while they heal and at the same time enable the athlete to walk in comfort if possible Figs. 22*a*, 22*b* and 22*c* completely illustrate a comforting and effective form of strapping which incorporates a stirrup A bandage such as this is especially suitable in numbers of cases.

A bandage that is useful and can be adapted either for a leg support or as a pressure dressing for facial injuries is shown in Fig 23 It is Elastocrepe and contains no rubber Its special weave enables it to be stretched to almost twice its length. It is a very economical type of bandage as it can be washed re peatedly and always retains its shape It is a very useful bandage for a busy trainer to have as a stand by

Wherever strong support is needed after severe injury Elastoweb may be used effectively The bandage is fitted with a special foot loop (Fig 24*a*) and the foot and leg can be band aged completely as shown in Fig 24*b* This type of bandage is extremely useful as it can be applied to a weak ankle or leg muscle prior to a game and no harmful effect is felt during exercise. Sometimes a paste bandage is used, and I know of



Fig 21b

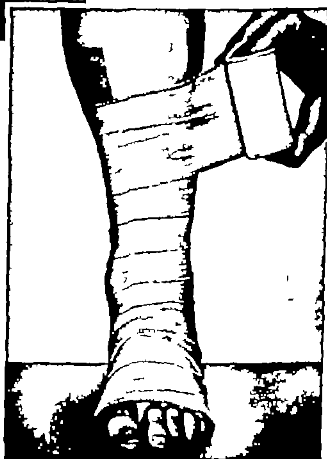


Fig 21c.

many club doctors who prefer this method of bandaging The type of paste bandage I have used extensively is known as Viscopaste and shown in Fig 25 It is easy to apply and is ready to use immediately after removal from its wrapper which is conveniently moisture proof

Sprained or Strained Wrist A three inch elastic plaster bandage is used for this in the following manner slit the bandage off centre for about four to five inches to give two tails—one one inch and the other two inches wide Apply to the palm side of the hand, each side of the thumb so that the narrower tail is close to the clefts of the fingers (Fig 26*a*) At the next turn the bandage is split as shown in Fig 26*b* The third turn of complete three-inch width is passed round the wrist under sufficient tension to obtain required support and maintain movement of the hand Bandage until the desired length is reached (Fig 26*c*)

Thumb Injuries Apply one-inch bandage in spica fashion round the thumb starting from within (Fig 27) An effective strapping for tendon strains of the wrist is shown in Fig 28 The fingers grip a complete cotton bandage while a portion of elastic bandage about three inches wide is applied over the upper surface of the forearm, over the clenched fingers and along the inner surface of the forearm to just below the elbow It is retained in position by a few turns of elastic bandage applied with moderate tension between wrist and elbow

Dislocations at the shoulder end joint[1] of the collar bone need a type of bandage to relieve weight of the arm and forearm on the joint. This is done by a collar and cuff sling and a further sling made from a three inch wide bandage The latter is applied as follows adhere the plaster to the skin at the base of the shoulder blade and carry it over the shoulder close to the neck. It is passed downwards in front of the collar bone and arm to the bent elbow and then under the upper three inches of the forearm which should be protected by a pad of sponge rubber and taken up the back of the arm to the starting point. Without cutting the bandage, the procedure is continued finishing up with the end of the bandage several inches below the collar bone. It is important that the crossing is made close to the base of the neck and under tension (Fig 29) An alternative method is shown (Figs 30*a* and 30*b*) by adhering a three inch strip of elastic plaster bandage folded back on itself for about six inches when it is wrapped round the forearm It is pinned as illustrated and then carried upwards and over the

[1]Acromio-clavicular joint



Fig 22a.

Fig 2

Fig 22c


Fig. 25.

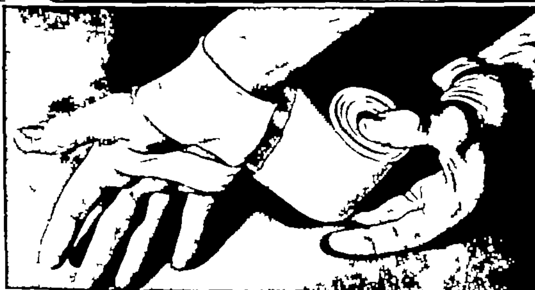

Fig. 26a.


Fig 26b.

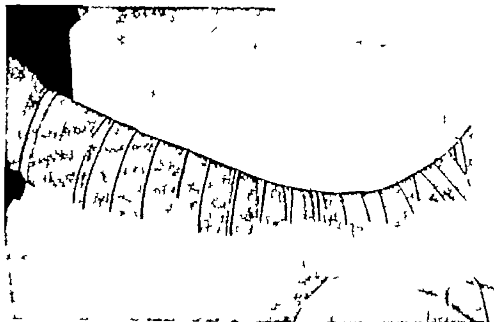


Fig 23



Fig 24a.



Fig 24b.



Fig 26c.

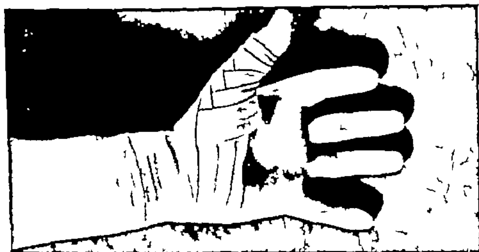


Fig 27



Fig 28

shoulder being pulled tightly as it is applied It is important that the plaster is kept near to the junction of the neck which is protected by sponge rubber It must be realized that there are many other conditions which may need strapping and padding, and adaptability on the part of the trainer will be necessary However a close study of the illustrations and text in the foregoing chapter will lay a foundation for the technique needed in strapping and padding athletic injuries While no chapter can possibly cover every conceivable type of strapping which may be necessary sufficient illustration has been given to take into account most of the forms of injury in which strapping is likely to be used

CHAPTER XXI

THE FUTURE TRAINING OF ATHLETIC TRAINERS

I FEEL that a volume which deals with injury and fitness of the athlete should not fail to discuss the future training of the athletic trainer While no attempt is made, nor should it be made, to assert that the present-day trainer, within certain limits, is not a capable individual, one cannot help coming to the conclusion that most trainers have very little foundation *for their job I personally know hundreds of trainers, many of* whom have indeed spent hours in pursuit of learning and knowledge in order to equip themselves for the task they have to do But to the majority, the profession of athletic trainer is largely a hotch potch of bucket and sponge men There is no doubt that effective standards must be laid down and with the help of the medical profession physiotherapists, and the many athletic organizations the Football Association, the Amateur Athletic Association National Cycling Union, British Boxing Board of Control, and the host of other sporting bodies, the athletic trainer should be trained to emerge as a fully qualified professional person with an accredited diploma. I have often failed to understand the purchase of say, a footballer costing thousands of pounds and the entrusting of his possible injuries to an ill-equipped and untrained individual, whose method of treating injury should not be applied to a dumb animal In fact I may assert that, if dumb animals were treated as I have personally seen athletes treated, very effective recourse to a protection society would have been made The amazing thing is that most trainers with whom I have discussed this matter have agreed with me and though there will no doubt be many who will take these criticisms to heart and resent them I would like them to believe that I make them for no other reason than that I would like to see established proper training schools and the efficient preparation of athletic trainers I am certain that there is every need for these schools and the setting up in connection with various technical colleges and stadia all over the country would set the seal on the advancement to a



Fig 29.



Fig 30a

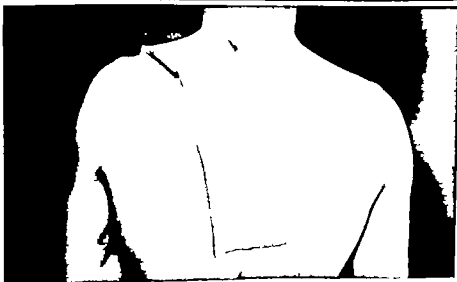


Fig 33b.

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Fig 29.



Fig 30a.

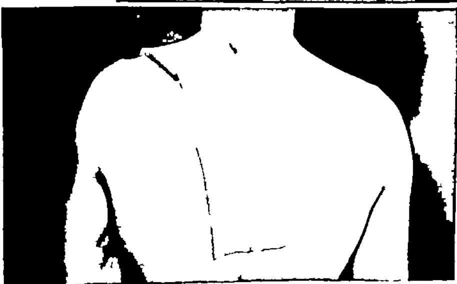


Fig 33b.

It should also be possible to found an Association of Certificated Athletic Trainers, which would control the study and training, in all methods including physical treatment, and which would co-operate in providing clubs or groups of athletes with fully qualified trainers I am quite sure that the professional organizations would be glad to assist in providing lecturers, both medical and physiotherapists, and would help in such a scheme, and possibly to set up a body to make research study into further branches of training and treatment for the benefit of athletes and athletics

Qualifications of Candidates for Entering Schools

Evidence of physical fitness

Candidates should be eighteen years of age and able to fulfil a certain educational standard

Scope of Training and Examinations The scope of training should be as outlined in the course of study and examinations would be held in parts The first two parts would be done on the work done during the preceding period and the last part would be a final comprehensive test of the candidate's ability to reach the standard of the diploma awarded by the examining authority

Course of Study—Part I

1 Elements of general science (chemistry physics biology etc)

2 Anatomy, physiology pathology

Part II

1 Applied anatomy and physiology

2 Theory and technique of massage, movements, electrotherapy and their application to athletic injuries

3 Construction and maintenance of apparatus used in treatment

Part III

1 Pathology and treatment of general medical and surgical conditions in relation to athletic injuries

2 General principles of rehabilitation.

3 General care with elementary psychology in handling patients

Many members of the medical profession with whom I have discussed the ideas already outlined are in full agreement as are also many of my fellow physiotherapists

recognized profession from the present state of empiricism. I do not want to make doctors or physiotherapists of athletic trainers—I merely would like to see them *fully prepared* and *educated athletic trainers* Sport, especially organized athletics has evolved so rapidly, and the athlete is such an important individual, that only the best form of handling is good enough It is useless to hope and strive for a four minute mile for an athlete and deny him the services of a trainer who may make this possible. I am convinced that the racehorse trainer knows far more about the horse, his anatomy, functions, diseases, etc, than many athletic trainers know about the human body its structure and functions Let us then do away with the past and progress towards the goal of as near perfection in the training and handling of athletes as may be humanly possible. The technique evolved in the United States, for instance, is sufficient indication There, the athletic trainer is a college man and as most athletes are college men also they can speak the same language, discuss the fundamentals of body stresses and strains, and so prepare as a team, with confidence and understanding for the physical exertion necessary in a sport and if injury does occur then the trainer because he has the fundamental knowledge of his job and all that it entails, will get the athlete fit as quickly as possible because he knows what he is doing and why

I am sure that the performances of so many transatlantic athletes is the result of this athlete-trainer combination and the confidence of the athlete in his handler

I am equally sure that to establish effective training schools very little money is required and the contributions of the sporting bodies need not be necessarily great A little from everybody would be sufficient once the will is there to start at the beginning

Outline of Suggested Syllabus and Curriculum

The curriculum would be designed to occupy about four or five terms of twelve weeks each, and the course would be full time day study Grants could be made to enable the less wealthy clubs to send suitable candidates for the full study course, and the schools could also accept outside candidates wishing to qualify as recognized athletic trainers Fees charged from this source would go to the school It would be necessary to establish an Examining and Registration Board which would control all examinations and registration of successful candidates

GLOSSARY OF TERMS

NOTE.—This glossary has been specially compiled by the author to give the young student of athletics and the athletic trainer as comprehensive a dictionary of medical terms as will assist them in their work

Abdomen The lower part of the trunk of the body, resting on the bones of the pelvis and separated by the diaphragm from the thorax, or chest The upper part of the abdomen contains the stomach, in front of which is the liver, and behind, the spleen, pancreas and kidneys, and below are the intestines

Abduct To draw away from the middle line of the body

Abductor A muscle which draws parts away from the middle line of the body or a limb

Abrasion A chafe, a spot rubbed bare of skin or mucous membrane.

Absorption The act of taking up by suction

Acceleration Quickening, as of the pulse or respiration

Achilles Tendon The great tendon of the heel, so called because it was said to be the only place where Achilles, the great Greek warrior and hero was vulnerable.

Acidosis A depletion of the alkaline reserve of the body Severe cases due to extreme fatigue following exercise are often called acid intoxication Retention of carbon dioxide in the blood due to under-ventilation of the lungs is known as CO_2 acidosis

Acute Sharp usually having severe symptoms and a short course

Adduct To draw towards a centre or the middle line of the body as opposed to abduct

Adductor Muscles which draw certain parts towards the middle line of the body or the axis of a limb

Adhesion The abnormal joining together of parts of the body

It remains only for me to hope that some such scheme may be commenced, because, if we are to remain a nation whose ideals of sport and sportmanship will always be a standard of envy and wonder, then the same progress must be made in this field as in any other Nothing stands still—we must go forward or backward—we have no alternative. To go backward is unthinkable, there is only one way we can go—on to new horizons in sport, training and participation, and to a new generation of athletic trainers If this book accomplishes nothing more than a controversy as to the necessity for these ideas to be translated into fact, then it will have done as much as may be considered a fair reward for the effort. If only a seed is sown perhaps one day the harvest will be reaped

THE END

BRONCHI	Branches of the trachea or wind pipe
CALCIUM	A chemical element, one of the main constituents of bone in the body, the metallic base of lime
CALORIE	The unit of heat to express the amount of heat required to raise a definite amount of water one degree Centigrade For practical and nutritious purposes the unit is 1,000 times this amount
CAPILLARY	A small blood vessel, connecting arteries and veins.
CARBO-HYDRATES	A class of substances such as the sugars, starches and celluloses consisting of carbon hydrogen and oxygen Important to all living animals and plants
CARBON DIOXIDE	A gaseous oxide of carbon having the chemical formula CO_2 It is present in the air and much of it is used by green plants The human body throws it into the air by respiration It has no smell but when in solution with water becomes carbonic acid, and is sold and used as soda water
CARTILAGE	Gristle All the bones of the body are developed from cartilage which hardens by the age of twenty-one
CELLULOSE	A carbohydrate substance present in the walls of living plants. Many uses are found for it in the manufacture of such things as rayon celluloid cellophane and many others.
CHEMISTRY	A branch of science which deals with chemicals and similar substances. Biochemistry is that branch of chemistry which deals with the investigation of chemical changes in living matter such as the body
CHYLE	A milky fluid one of the ingredients of food assimilated by the blood following chemical action in the body
CLAVICLE	The collar bone
CONTRACTILITY	In a muscle the power of shortening
DEXTRIN	A gummy substance obtained by heating starch or starchy products Often used in the manufacture of gum
DIAPHRAGM	Muscle dividing the chest from the abdomen

ALIMENTARY	Refers to food or nutritious material The alimentary canal is a tube about five or six times the length of the body lined with mucous membrane and extends from the mouth to the anus and includes stomach intestines etc.
ALKALI	Any one of a class of compounds which form salts with acids and soaps with fats.
ALKALINE RESERVE	Total of alkaline salts in the body which can act to keep up the normal alkalinity of the blood
ALL OR NONE	The law that the heart muscle, under whatever stimulus, will contract to the fullest extent or not at all.
ALVEOLUS	A hollow or sac in lung tissue into which air is drawn
AMPERE	Unit of electric current strength In medical electricity milliamperes are used, and a meter is placed in the galvanic circuit to facilitate easy reading of current strength (Milliampere = 1/1000 amp)
ANATOMY	The science of the structure of the body
ANODE	The positive electrode in medical electricity
ANTAGONIST	A muscle which counteracts the effect of another muscle.
ANTISEPTIC	A substance which is destructive to the germs of disease
AREA	Of the body—a limited space
ARM GLASS	A condition of the arm due to an injury of the long tendon of the biceps muscle. Often occurs in tennis or golf hence the terms—golfer's arm or tennis shoulder
ARTERY	A blood vessel which conveys blood from the heart
ARTICULATION	The place of union or the junction between two or more bones of the skeleton.
ATHLETE'S FOOT	A fungus infection of the feet
ATHLETIC TYPE	To refer or denote a body type—characterized by physical strength
ATROPHY	Wasting or loss of size
BIOLOGY	The science of living things.

Lactic Acid The general name for several organic acids having the same chemical formula and composition The most familiar is the acid produced in sour milk by the fermenting action of bacteria upon lactose or milk-sugar Lactic acid forms in muscle tissue being responsible for muscle fatigue

Lactose Milk-sugar, the sugar which forms an integral part of all animal milk.

Lanoline A greasy compound of wool fat and water used as a basis of various ointments for application to the skin

Larynx The organ of voice, situated in the upper part of the throat It is very like a cylindrical box

Lymph A transparent alkaline watery fluid found in the tissues. It conveys substances for blood formation, waste matter from the tissues into the blood

Lymphatics The vessels by which lymph is carried from the lymph glands, situated in the groin, armpits neck, etc., to the various parts of the body In structure they resemble the veins, and form a circulatory system very like that which conveys blood through the body

Magnesium A metallic chemical element one of the constituents of green colouring matter in plants

Maltose Malt-sugar produced from starch and converted into glucose or grape-sugar by chemical action

Metabolism The name given to the chemical changes continually in progress in the cells of living matter

Molecule The smallest particle of an element or compound that normally leads a separate existence

Nutrient Any substance which provides food

Origin Where applied to muscle—the start or beginning of muscle fibres in immovable bone

Oxidation A term applied to a chemical change whereby oxygen is added to an element or compound An oxidizing agent is any substance which has the property of giving up oxygen to other substances

Patella The knee-cap

Pericardium The membrane which encloses the heart

DIASTASE	Soluble ferment formed in germinating grain capable of converting starch and dextrine into sugar
DILATION	To enlarge or expand
ELASTICITY	Capable of extension.
ELECTRODE	Either of the terminals of an electric current. The positive is called the anode and the negative the cathode.
EFFUSION	The act of pouring out escape of fluid from any vessel or organ holding it.
ERGOSTEROL	A substance produced in the skin by ultra violet rays which assists in the manufacture of vitamin D
EXTENSIBILITY	Capable of extension.
EXTENSOR	A muscle that extends, or straightens a limb
FASCIA	The thin sheath of tissue binding muscle.
FAT	A solid oily substance forming part of the tissue of animals.
FLEXOR	A muscle that acts in bending a joint, opposing extensor
FRUCTOSE	Sugar found in ripe fruit, starches and honey
FULCRUM	The part of a lever in which it turns.
GLUCOSE	The particular form of sugar existing in many animal and vegetable organisms.
GLYCEROL	Glycerine a colourless sweet liquid.
GLYCOGEN	A starch like substance obtained from animal tissues especially the liver
GRANULATION	The forming of tissue on wounds when healing
HAEMORRHAGE	Bleeding
INSERTION	Referring to where a muscle is attached to a bone which is movable.
IODINE	A non metallic chemical element belonging to the salt forming group The body of a normal full-grown man contains approximately twenty milligrammes of iodine about half of which is present in the thyroid gland as the compound *thyroxin* Much of this iodine is supplied to the body in certain foodstuffs such as butter milk, spinach etc Iodine is essential to health and as a tincture is used as an efficient antiseptic.
ISOSCELES	Having two equal sides.

SPASM	A sudden convulsive movement in muscle, due to abnormal working of the central nervous system. The condition is rather a symptom than a disease
STARCH	A carbohydrate found in most plants. A foodstuff of great importance. It is changed into sugar by the operation of certain chemical actions
SYNOVIAL FLUID	A fluid secreted by the synovial membrane or lining of the joints which keeps the joints lubricated
TRACHEA	The windpipe. At its lower end it divides into the two bronchi which connect it directly with the lungs
VEINS	The vessels which carry the blood from the tissues to the heart
VITAMINS	Complex organic compounds discovered in the early part of the present century by Sir Frederick Gowland Hopkins. Small quantities of vitamins are necessary to the healthy functioning of the body

PERIOSTEUM	The membrane which covers the bones.
PHOSPHORUS	A chemical element essential to living matter An important mineral constituent of bones. It owes its name to a Greek word meaning 'light bearer' owing to its property of shining in the dark
PHYSICS	A general term signifying the sciences dealing with natural phenomena such as motion heat, light, sound etc It may be said to extend to all the sciences not specifically biological or chemical
PHYSIOLOGY	The study of the function of the body
PLASMA	The fluid basis of blood
PROTEIN	Complex compounds which are essential to animal and plant life. Plants can build up proteins from nitrogen in the soil but man obtains his from animal or vegetable sources
PROTOPLASM	The physical basis of all life the matter of which the cells of animals and plants are constituted
QUADRICEPS MUSCLES	The muscles on the front of the thigh, which extend the knee
RADIATION	The name given to energy in the process of transmission as electro-magnetic waves Different names are given to each radiation according to the wave length The shortest are the cosmic waves followed by the gamma waves of radioactive bodies X rays ultra-violet rays, visible light (violet indigo blue green yellow, orange, red) infra red and other heat rays, and then the electric waves used in wireless transmission *Radiation occurs in straight lines only its* velocity is that of light
REFLEX ACTIONS	Name given to the mechanical reactions which an animal manifests in answer to a certain stimulus All organisms whether animal or plant show them to an important degree
SAPONIFICATION	Decomposition of a fat by an alkali, with the formation of a soap or glycerine
SCAPULA	The shoulder blade a flat triangular bone which forms the chief part of the shoulder girdle.
SECRETION	A liquid excreted by a gland in the body necessary to the function of the body

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